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The price of energy security: Comparing the *rationale* of shale gas exploitation in Germany and Poland from an environmental perspective from 2010 to 2015

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Abstract

The exploitation of (unconventional) shale gas has been discussed controversially. On the one hand, environmental concerns have been raised regarding at the necessary technique of hydraulic fracturing to produce these resources. Water consumption and pollution, as well as seismic activities are the main risks of fracking process. On the other hand, fracking has a positive impact on economic profits and energy security for countries through autonomous gas production.

The priorities of Germany and Poland have been analyzed in a case study to examine their rationale in making a decision concerning fracking. A rational choice approach has been applied for the analysis. Germany is hesitant regarding fracking, due to potential environmental risks. The countries energy policy is oriented towards an environmentally sustainable energy concept. Combating climate change is one of Germany's interests and therefore renewable energies are in the government's focus.

Poland shows a positive attitude towards fracking as it offers a possibility for the country to gain more independence in terms of energy supply, especially from Russian gas imports. This promise of more energy security and economic profits makes the government establish fracking-favoring energy policies.

Keywords:

Energy Policy; Energy Security; Environment; Environmental Risks; Fossil Resources; Fracking; Hydraulic Fracturing; Germany; Poland; Rational Choice; Security of Supply; Shale Gas; Unconventional Gas

Table of contents

1. Introduction 4
   1.1. Research Question 5
   1.2. Theoretical Framework 6
   1.3. Methodology 7
   1.4. Scientific Relevance 8
2. Shale Gas Exploitation, Economic Profit and the Environment 11
   2.1. Fracking as a Technique 11
   2.2. Environmental Concerns 13
   2.3. Profitability 15
   2.4. Energy Security 17
   2.5. European guidelines 20
3. Germany 22
   3.1. Energy Matrix and Shale Gas Resources 22
   3.2. National Legislation 23
   3.3. Analysis of the German Perspective on Fracking 24
   3.4. Interim Conclusion of Country's Priorities 30
4. Poland 31
   4.1. Energy Matrix and Shale Gas Resources 31
   4.2. National Legislation 32
   4.3. Analysis of the Polish Perspective on Fracking 33
   4.4. Interim Conclusion of Country's Priorities 38
5. Conclusion 40

References 44

Figures 52

Tables 53

Abbreviations 53

Annex 54

1. Introduction

Energy moves people and energy moves states. It moves their industries, their transport system and their military. Thus, securing continuous access to energy is a key priority for each state. Considering this, whether energy should be produced autonomously or whether it should be imported is an important question. In other words, if energy moves people and energy moves states, where does energy come from? Natural resources belong to the environment, which, logically seen, would be likely to be protected by humans as their habitat. Nevertheless, human needs have a high priority which makes it necessary to analyze governmental decisions that impact on both aspects: the environment and human demand for secure energy.

The main energy sources that are exploited at the moment are still fossil energies[1], such as oil, gas and coal. With the recent Ukraine crisis and the resulting conflict with Russia, the discussion of energy dependence for the European countries importing oil and gas from Russia has gained new importance[2]. Being dependent on foreign energy might mean to be dependent as a state on another state and this might result in reduced political freedom of action. Energy security is the concept defined "to assure adequate, reliable supplies of energy at reasonable prices and in ways that do not jeopardize major national values and objectives" (Yergin 1988, p. 111). These values and objectives can be different in each state which is one reason why there is no comprehensive EU policy on energy security so far, even if the matter was mentioned in the Lisbon Treaty (European Commission 2014c, p. 4).

In recent years the technology of hydraulic fracturing has been developed further in the United States[3] and has eased the access to additional energy sources, such as non-conventional gas reserves. With this technology the reserves locked up in shale gas can be partly extracted and countries can diversify their energy supply. One obstacle to the "fracking" technology may be the environmental risk as it can pollute the groundwater, cause instability in geological plates and decrease quality of life for people in the surroundings (Simon et al. 2013). Still, the significance of these risks has not been sufficiently proven, which prohibits declaring fracking as harmless or dangerous (MKULNV 2012).

In a parliamentary debate about a new legislation concerning the fracking technology and its implementation in Germany, the initial statement of Dr. Barbara Hendricks, the German Federal Minister for the Environment, Nature Conservation and Nuclear Safety was: "We do not need new fossil energy sources[4]" (Deutscher Bundestag 2015a, March 7, p. 9780, translation myself). She further stated: "I am not even sure if the fracking technology in a commercial

[1] In 2013, the percentage of fossil fuel consumption of total primary energy consumption amounted for 86.7% in the world (BP 2014, p. 41).

[2] Since many pipelines carrying gas from Russia to the EU lead through Ukrainian territory, an insecurity of supply could be caused by regional political tensions as the territory is not operated under EU law (European Commission 2014c, p. 50).

[3] Information on fracking in the United States: API 2015; Boersma, Johnson 2012; Medlock III et al. 2011; EIA 2015

[4] Original wording: "Wir brauchen keine neuen fossilen Energiequellen." (Bundestag 2015, p. 9780)

sense has a future in Germany, if there is even a commercial interest, to apply it on unconventional areas[5]" (Bundestag 2015, p. 9782; translation myself). This quote shows what has been the strong opinion of German policy makers against the implementation of the fracking technology. In contrast to this, the Polish Minister of Economy, Janusz Piechociński, argued that "increased domestic supply will contribute to limiting our dependency on deliveries from a single source, allowing us to achieve, as a consequence, a higher level of energy security" (Squillante 2014). When comparing these two attitudes, the width of the argumentation regarding shale gas exploitation is evident. In terms of natural gas, both countries are net gas importers which creates a dependency on other countries: in 2010, the IEA reported an import dependency for Germany of 85.5% (77,027 mcm/y[6]) for natural gas and 64.1% (11,112 mcm/y) for Poland (IEA 2011a, 2012b).

1.1. Research Question

Due to the known environmental risks of this technology (see Chapter 2.2), the public debate is quite controversial. As every state has its own priorities in its political agendas, decisions and policies concerning hydraulic fracturing can have different outcomes. The purpose of this paper will thus be to analyze and compare how Germany and Poland assess the possibility of producing shale gas in their country and how environmental concerns are valued in the trade-off between a potential increase of security of supply and a possible hazard of the environment. The analysis will be guided by the following research question:

> ***How is the exploitation of non-conventional gas sources, particularly shale gas, evaluated in Germany and Poland and to which priority do the elements of energy security, economic benefit and environmental compatibility obey?***

As this question is relatively complex and contains different aspects, the sub questions below should help to provide more structure and to give separate responses to the components:

1. What are the environmental concerns towards fracking from a scientific perspective?
2. How is national energy security addressed by considering the exploitation of shale gas?
3. To what extent does the possibility of hydraulic fracturing coincide with the countries' policies on energy and what are its implications on the environment and previous environmental protocols?
4. Where does the environmental variable stand in the countries' policy priorities?

In the second chapter the theoretical background for fracking technology with its opportunities and constraints will be given to answer sub question 1 and the profitability will be elaborated. The connection between shale gas exploitation and energy security should be established in chapter 2.4 and in the analysis parts for each country (3.3 and 4.3). A short overview

[5] „Ich bin auch nicht sicher, ob die Fracking-Technologie im kommerziellen Sinn tatsächlich eine Zukunft in Deutschland hat, ob es ein kommerzielles Interesse daran gibt, sie überhaupt in dem unkonventionellen Bereich zur Anwendung zu bringen." (Deutscher Bundestag 2015, p. 9782)

[6] million cubic meters/year

on European guidelines on fracking will be helpful to evaluate eventual restrictions for the countries. In the third and fourth chapter, the third sub questions should be answered for each state, including the evaluation of national preferences and legislation regarding the exploitation of shale gas. The forth sub question will be answered implicitly in the analysis parts and explicitly in the conclusion.

1.2. Theoretical Framework

To approach the relevant aspects and arguments in this paper, a rational choice theory will be applied. The theory enables to analyze the countries' decisions on shale gas exploitation in the light of national policies on the topics of energy security and the environment. These policies are assumed to be rationally developed and logically traceable. Rational choice theory enables an equal assessment of the priorities, assuming that governments are weighing costs and benefits against each other (Eriksson 2011, p. 17). Germany and Poland are expected to act in favor of maximizing their own utility in terms of pursuing their national political aims. The research question requires to evaluate the pros and cons of the establishment of the fracking technique as tool to achieve more energy security while taking environmental concerns into account.

Rational choice theories are mainly economically oriented and many authors follow the assumption that actors rationally pursue the maximization of utility while having consistent preferences (Eriksson 2011, p. 17). In comparison, in security studies game theory is often applied to rational choice matters as not only one actor's 'rational choice' is relevant for decisions, but "the outcome for each actor will be affected by the choices that others make" (Walt 1999, p. 10). Focusing on *utility maximization*, the analysis of decision making processes is relatively simple as only three dimensions are most important, which are the ones of *utility, probability* and *costs* (Stocké 2002, p. 9; Eriksson 2011, p. 20). While the utility dimension seems quite obvious, the probability dimension represents the likeliness of a happening following a decision and the cost dimension includes factors like opportunity costs or time for the acquisition of information.

To achieve highest utility, actors are assumed to "have preferences concerning certain action alternatives, prioritizes them along their utility and finally choses the highest preference[7]" (Dehling, Schubert 2011, p. 31, translation myself). For the analysis of the German and Polish priorities, the term of rationality has to be specified to be "thick rationality" (Dehling, Schubert 2011, pp. 38–42), as the substantial component of utility only matters here. "Thick models of rationality impute specific preferences and beliefs to individuals, often through blanket assumptions" (Chai n.d., p. 16), with which it is assumed that preferences of individuals are similar, and therefore also those of groups[8], which makes it possible to evaluate the relative utility

[7] Original Wording: "dass eine Person über Präferenzen bezüglich bestimmter Handlungsalternativen verfügt, diese entsprechend ihres Nutzes logisch konsistent ordnet und die am höchsten eingeordnete Präferenz von ihnen schließlich wählt" (Dehling, Schubert 2011, p. 31)

[8] The concept of methodological individualism describes this effect, stating that the behavior and decisions of individuals are most of the time generalizable to the behavior of the public. The reason for this phenomenon is

of a decision. Based on the definition as preferences being constructed by an individual evaluation of alternatives, further self-interest as background for this prioritization will be supposed (Eriksson 2011, pp. 17,22-23).

According to Becker, it is also possible to shift the applicability of the originally economic theory to non-market goods (Becker 1978, p. 402). For Goode people are very likely to "seek another good, moral utility, by conforming with a rule they feel is right, just, or ethical" (Goode 1997, p. 25). Referring to the content of this paper, a similar attitude towards the relevance of environmental protection and energy security for states is presumed. Obviously, energy security and environmental protection are no classical market goods, accordingly their importance for nonmaterial values seems to be a relevant factor here.

A change in preferences can happen if a scarcity of goods with high value or high priority occurs, which in this case would be a shortage or a threat of energy supply (Stocké 2002, p. 16). As sometimes complete information is not available and to seek information costs time and money, decisions are made while not considering entire aspects (ibid, p.16). Applying this to the debate about fracking, it is probable that decisions are made pursuing the states preferences while there is no comprehensive information about all environmental and political issues available.

1.3. Methodology

A case study will be employed as research design since it offers the possibility to examine Germany and Poland as 'two similar cases'. Nation states can be selected as units of analysis on a "macro-level" if they are involved into the phenomenon of interest (Swanborn 2010, p. 6). The countries "are similar across all background conditions that might be relevant to the outcome of interest" (Seawright, Gerring 2008, p. 304) i.e. being member of the EU, being industrialized and democratic countries and being net natural gas importers. In this research design, "the cases differ, however, on one dimension—X1—and on the outcome, Y" (ibid, p.304), whereby the dependent variable is the establishment of fracking (or not) and the independent variable of interest are the countries' priorities that determine the decision.

The research question has an exploratory character as it is an X-centered research (Seawright, Gerring 2008, p. 298) and it should be figured out which variables have the highest influence on the establishment of fracking in national policies. According to Gerring, a case study serves exploratory purposes, as it is "enabling one to gain more in-depth knowledge of one or a few cases that are thought to exemplify key features of a topic" (2012, p. 52). A descriptive component of this research is to outline existing knowledge about a phenomenon (Weischer 2007, p. 108), which is particularly relevant when describing the technique and the environmental risks of fracking in Chapter 2.

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that the methodological individualism analyzes all relevant components on the individual level which makes a groups decision the exact sum of individual decisions. (Schubert p.26-28)

As the research questions on the one hand contains the abovementioned exploratory elements, it implicitly includes the question of *'how* are the states dealing with the fracking issue' and according to Yin, case studies are a suitable instrument for how-questions (Yin 2003, p. 7). The research will be conducted focused on only one point in time but also with regard to past events. The following definition by Yin provides the basis for this paper:

> *"A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin 2003, p. 13)*

This definition gives a perfect framework for investigating the explanations and concerns about the topic of shale gas exploitation while current debates about environmental protection and energy security represent the real-life context.

As in social science, often the "concern in this genre of work is not a class of outcomes but rather a particular outcome pertaining to a particular country" (Gerring 2006, p. 708), the research for this paper will be conducted as a desk research. Case studies allow to conduct this kind of observational instead of experimental studies (Gerring, McDermott 2007, p. 688).

With regard to the comprehensiveness of the topic of fracking with all its consequences, it is practical, that it is convenient for case studies to analyze "multiple sources of data to capture this complexity" (Rosenberg, Yates 2007, p. 448). Hence, secondary literature of authors and of national and international organizations, as well as primary data from institutions should be evaluated in order to get a broad overview of the topic. Secondary data analysis means to evaluate data collected for another purpose than the actual paper (Flick 2009, pp. 129–130). Due to the ongoing research process, online articles and websites may provide the newest information and will therefore also be used.

The term of case study may describe such research, which aims to "collect information about developments during a specified period" (Swanborn 2010, p. 17). The timeframe for this analysis will be the time from 2010 until July 2015, to include newest developments. In 2010 and afterwards, several incidents relevant for potential fracking activities in Germany and Poland could be identified[9], such as the announcement of the German Energy Transition through the Energy Concept in 2010 followed by the decision for a nuclear phase-out in 2011. In Poland, 2010 was the year of a first exploration well for fracking (The Economist 2013) and soon after in 2011, the Geological and Mining Law was amended, reforming the legal situation for companies interested in fracking.

1.4. Scientific Relevance

One challenge for making decisions concerning the energy sector is that policy makers have to find a way that "balances security, economic, and environmental interests" (Andrews 2005,

[9] A more detailed description of the subsequently mentioned incidents will be given in the analysis part in Chapter 3 and 4.

p. 24; Mükusch 2011), which will later be mentioned again as targettriangle to describe energy policies (Chapter 3.3 and 4.3). The "efficiency rationale" is described as important concept for the energy sector as its purpose is to intervene when markets fail. Next to monopolies, externalities and public goods are the determining variables requiring correction (2005, p.21), whereby the latter ones represent perfectly the controversy of fracking: environmental pollution as negative externality is opposed by the public good of energy security. A normative key question asked here is if "public policies make unreasonable tradeoffs between security and other objectives?" (p. 21).

For some authors of the Heinrich Böll Foundation[10] in Germany and the Friends of the Earth Network, a clear answer is given to this question: shale gas exploitation is a severely overestimated issue emerging from an US trend whereby it is dealt recklessly with environmental risks (Simon et al. 2013, pp. 12, 57). In particular, a lack of legislation in Germany is claimed, demanding more protection for ecosystems, including groundwater that also relates to the alimentation industry (pp. 55-57). Not all risks of the fracking technique and especially long-term risks are known yet, which makes a more responsible handling necessary. Also regarding to EU frameworks (see Chapter 2.5), the Heinrich Böll Stiftung underlines a conspicuous constraint, as on the one hand sustainability of policies should be increased and on the other hand states establish hydraulic fracturing which definitely counteracts to the implemented polluter pays principle (Simon et al. 2013, pp. 57–58).

Energy security is an important target for Poland. Piechocki (2010) sees Poland confronted with a significant dependence on Russia and challenging guidelines of the EU (pp. 100, 104). Its main goal will thus be to focus on the diversification of energy sources and to improve its own industry which contains also an expansion of its nuclear and coal sector, as well as the adoption of renewable energies and shale gas exploitation (p. 102). Renewable energies are the main obstacle to reach referring to EU guidelines. Piechocki emphasizes the proposal of the Polish government to create an intergovernmental crisis reaction mechanism "which would oblige all member states to solidarity" (2010, p. 109). Here it can be concluded, that energy security is quite important for Poland which makes it very likely to engage in fracking activities, whereby the decision in favor of shale gas exploitation as a project had anyway been made (Piechocki 2010, p. 102). A reason for the significance of the topic relates to the problem mentioned also by Andrews (2005), that political and economic issues are often not sufficiently differentiated and politically the fear of dependency on Russia is something omnipresent in Poland (Piechocki 2010, pp. 114–115).

Comparing a report of the Polish Geological Institute and the National Research Institute with one report of the Ministry for the Environment[11] of North Rhine-Westphalia (MKULNV), Ger-

[10] The Foundation is close to the Green Party in Germany, the Bündnis90/Die Grünen.
[11] Ministry of Climate Protection, Environment, Agriculture, Conservation and Consumer Protection of the State of North Rhine-Westphalia, Germany

many, an enormous difference in the evaluation of fracking gets obvious. While Polish scientists evaluate one fracking project conducted in the Łebień LE-2H exploratory well in 2011 and come to the conclusion that fracking "does not bear any long-standing influence on the environment, providing that it is appropriately performed, in accordance with the best professional knowledge and all the legal regulations" (Polish Geological Institute, National Research Institute 2011, p. 66), German authorities come to the conclusion that due to the lack of sufficient and reliable data it is not recommendable to permit further exploration and exploitation activities (MKULNV 2012, p. 63). Particularly the assumption of a huge amount of frack fluids staying in the soil after extraction is considered a great obstacle for establishing fracking in Germany (p. 26).

Other authors having published about fracking or shale gas, e.g. Gény (2010) and Brooks (2013), who analyzed the political and market based differences between the European and the U.S. unconventional gas markets and conclude that "land access restriction and high costs" (Gény 2010, p. 2), are the main constraint for Europe. Furthermore, the cheaply available coal hinders shale gas to become successful in Europe (Brooks 2013, pp. 40–41).

Teusch (2012) focuses on the possible impact of shale gas in reducing the energy import dependency through shale gas and infers that internal markets are more important as well as a united bargaining of the EU. Referring to his research, shale gas will only be established if it is proven to be economically and environmentally suitable. Medlock III et al. (2011) from the James A. Baker III Institute for Public Policy conducted a study with the purpose of analyzing the impact of shale gas extraction on geopolitical relationships of the U.S. to examine its beneficial effect on U.S. interests and security.

Llewellyn et al. (2015) studied the prevalence of natural gas and foams in drinking water around a well in the Marcellus Shale, Pennsylvania, leading them to the result that contaminated water might flow upwards through the borehole, but not through fractures. Another work was dedicated to the analysis of gas migration, also in the Marcellus Shale, was conducted by the U.S. Department of Energy and the National Energy Technology Laboratory, concluding that there was no migration of natural gas or brines between the shale and overlying Upper Devonian/Lower Mississippian gas field (Hammack et al. 2014, pp. 45–47). In the same context, Meng (2015) exercised a distance and intensity based analysis of the risks of fracking for the environment and the population in Pennsylvania, showing how many people are exposed to high to low risks of fracking.

This small selection of publications referring to energy security or hydraulic fracturing and its implications, provide an overview of the controversy of the topic and can therefore prove its scientific relevance. Especially the fact, that research institutes come to this different conclusions when evaluating fracking projects enables the assumption that political factors play an important role as it is mentioned also in Andrews (2005).

2. Shale Gas Exploitation, Economic Profit and the Environment

2.1. Fracking as a Technique

Hydraulic Fracturing, short fracking, is a technique to exploit unconventional gas resources. Shale gas is one of these "non-conventional" gases, meaning that it is "considered difficult or costly to produce" (IEA 2012a, p. 18) since the gas is located e.g. in shale formations with low permeability (ibid.), but the term also includes "natural gas in tight sandstones and carbonates (tight gas), shale gas, coal bed methane, aquifer gas, and gas from gas hydrates" (BGR 2013, p. 41). Tight gas is normally defined as resources stored in rocks with a "permeability of less than 0.1 Millidarcy (mD)" (ibid, p.42). There is a difference between shale gas resources and reserves, as resources are the proven existing amounts and reserves are the amounts which are accessible for extraction (Simon et al. 2013, p. 13). One difference for the production process is that more drilling activities are necessary for unconventional gas in one production area (ibid, p.1).

In order to perform fracking, a well site of approximately 100m by 100m has to be chosen, while the so called "Raumwiderstand"[12] should be taken into account, which measures all components of environmental compatibility for resource extraction, including population density, waters, soil conservation and landscape. (MKULNV 2012; IEA 2012a, p. 22)

The fracking process (see also in the figure below) begins with vertical drilling which is proceeded by horizontal drilling depths of hundreds to thousands of meters. The well is prepared with "a combination of steel casing and cement […] designed to withstand the cycles of stress" (IEA 2012a, p. 23). A fracking fluid, usually consisting of 90% of fresh water, 9.5% sand or ceramic beads and 0.5% chemical additives[13] is injected under high pressure after drilling (API 2015, p. 8).

Although the fundamental process of fracking might be the same for all wells, each one has its "unique properties that need to be addressed through fracture treatment and fluid design"[14] (Gandossi 2013, p. 8), which leads to a variation of costs and productivity of wells.

[12] One translation could be "territory resistances".

[13] Fracking additives can be acid, sodium chloride, polyacrylamide, ethylene glycol, borate salt, sodium/potassium carbonate, glutaraldehyde, guar gum, citric acid or isopropanol, which all are substances that can be found in products of daily life (API 2015, p. 8). According to acatech, 50 chemical substances are available in Germany for frack fluids, whereas none of them exceeds the lowest water hazard class (acatech 2014, p. 8). In an analysis of a selection of material safety data sheets referring to fracks in Germany, the Federal Environment Ministry examined that only 27 of 80 analyzed frack fluids were classified as "not dangerous" (BMU 2012, pp. A72).

[14] Cf. footnote 16

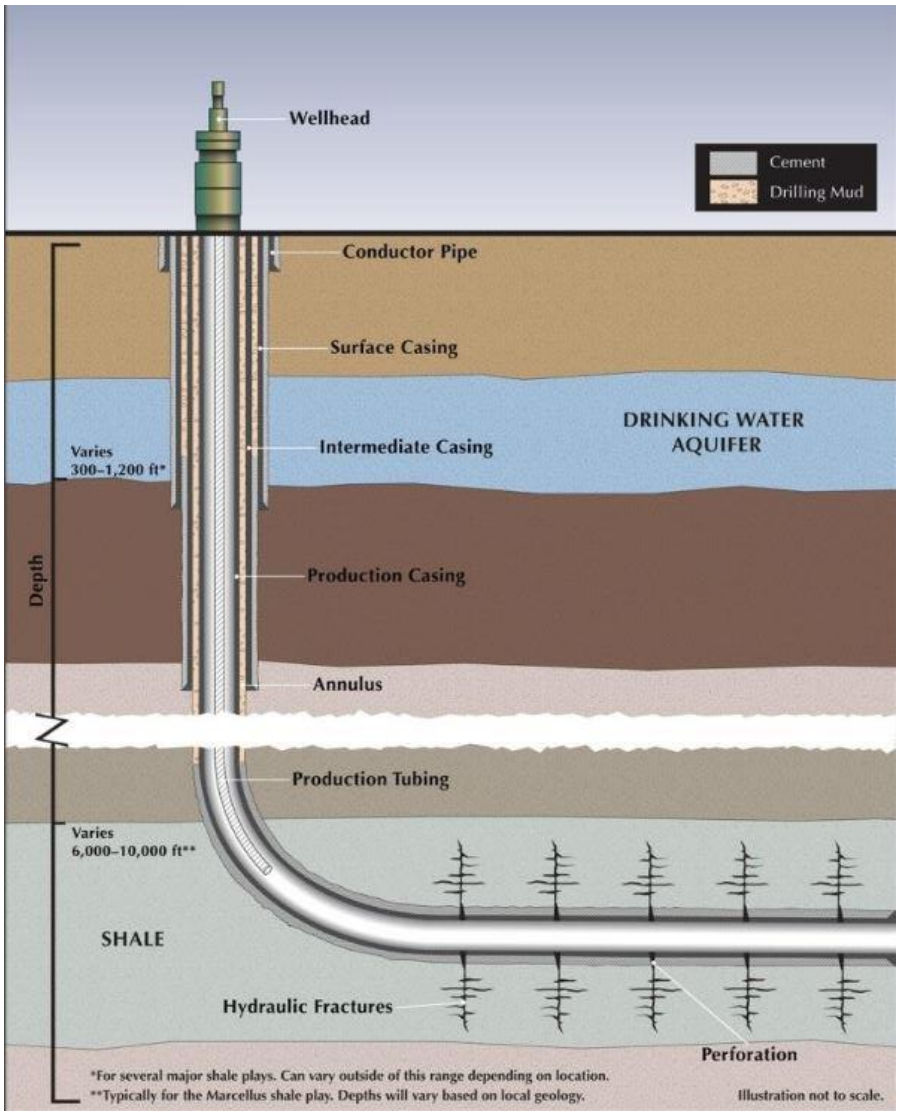

Figure 1 Fracking: Typical Horizontal Drilling (Argonne National Library 2013, p. 2)

The frack fluid is supposed to keep the horizontal fractures of the drilling process open, in order to let the shale gas stream up to the surface. Due to the high pressure inside the rock, the fluid (partly) flows back to the surface. This 'flowback' contains water with a high concentration of chemicals (those inserted with the fracking fluid), but also heavy metals or other solutes from the ground. This contaminated water has treated or stored afterwards. (Polish Geological Institute, National Research Institute 2011; EPA 2014)

Neither the complexity of technical knowledge required for the fracking process, nor the abundance of reserves is the determining variable for success. More important than these variable is "the availability of infrastructure or the legislative frameworks" (BGR 2013, p. 42). This statement made by the German Federal Institute for Geoscience and Natural Resources (BGR) underlines the high degree of politicization of fracking, which may sometimes weigh out technical accessibility or economic profitability.

2.2. Environmental Concerns

If fracking is mentioned in reports, articles etc., environmental risks[15] are the aspect which is immediately associated. This is why, when dealing with this technique one should be aware of the extensive consequences that have to be taken into consideration.

First of all, the ground and drinking water can be affected, which is the most important concern. As the hydraulic fracturing technique cracks rocks horizontally around the drilling hole, it is possible that rocks lying above the reserves of interest also break and that released liquids and gases can find their way into layers of rock containing ground water. (Simon et al. 2013, pp. 38–39).

Water is a very relevant issue for fracking. For a single drill (when working with water-based frac fluids), the amount of water needed can be up to thousands cubic meters of water[16] (Umweltbundesamt 2015). The problem hereby does not only result out of the amount of water that is used but also from the fact that this water is mixed with chemical additives, proppants and sand. The 'flowback' may, additionally to the intentionally added chemicals, carry other substances[17] back to the surface. (EPA 2014). Particularly the flowback is problematic as after pressing the fluids into the well, it is only partly extracted afterwards. One disadvantage when employing water-based frack fluids is that "the majority of the water pumped down hole during stimulation treatment is never recovered" (Watts 2014). Accordingly, the flowback is only a share of the total used frack fluid. (MKULNV 2012, p. 23)

Treating this polluted industrial water is a challenge for both companies and communes[18]. This water can either be stored and may be used again, or treated in order to clean it[19]. Separating water from chemicals and sand still leaves the question of how to dispose the remaining substances. (MKULNV 2012; Polish Geological Institute, National Research Institute 2011)

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[15] Examples for environmental risks are seismic activities, the pollution of groundwater, contamination of the ground, blow-outs, consumption of fresh water or emissions to the atmosphere during exploitation (Healy 2012; Simon et al. 2013, pp. 36–44).

[16] Using water based frack fluids is most common, as it is relatively cheap. Depending on the formation, it can be recommendable to use nitrogen or carbon-dioxide as 'energizers' for the fluid to substitute water partly or even completely. By making use of these gases, e.g. a higher productivity of the well can be achieved and less fluid remains in the rock which can be favorable for its stability. Referring to the concentration of nitrogen, frack fluids can be pure gas, foam, energized or ultra-high quality mists. (Air Products and Chemicals, Inc.; Watts 2014)

[17] There are substances like brines, heavy metals, hydrocarbons and radionuclides in the soil that can accidentally be dissolved during drilling activities and be carried to the surface with the flowback (EPA 2014).

[18] For companies the treatment or disposal of frac fluids is costly and communal sewage plants are not constructed for this kind of chemically polluted water. If water is treated there it might still contain radioactive substances, bromides and chlorides when it is dumped into a river and the sediment in sewage plants contain an increased concentration of chemicals which also has to be handled afterwards. (Chameides 2013)
For example in 2012, the Niagara Falls City Council decided not to allow the treatment of frac fluids in their municipal sewage plant as they did not want to risk a pollution of the river (Navarro 2012). A similar case can be identified in Pennsylvania from 2011, where some sewage plants neglected the treatment of frac fluids due to incapacity (Malloy 2011).

[19] Possible treatments for industrial water are e.g. a treatment with other chemicals or UV, ozone oxidation, deionization, nano-filtration or hydroclones (API 2015, p. 14).

Secondly, besides the water use, there is the concern of earthquakes[20] that might result from the intense drilling activities, as well as from any activities in the ground (IEA 2012a, p. 26). For non-conventional gas exploitation, there is often more than one well necessary on one square kilometer whereas for conventional exploitation usually only one well is needed in ten square kilometers (IEA 2012a, p. 19).

Thirdly, shale gas is a fossil resource[21]. Measuring the impact of CO_2 emissions of the whole process from shale gas production until combustion, it becomes evident that it is not the preferable way to reduce total greenhouse gas emissions[22] in order to halt climate change (Simon et al. 2013, p. 30). Especially methane, which is an important component of natural gas[23], contributes significantly to the greenhouse effect when streaming up during the production process (ibid, p. 31-32).

[20] Reports from e.g. Oklahoma and Texas have observed, that "fracking with high pressure has the potential to cause small earthquakes" (Meng 2015, p. 199), but it is still not proven absolutely if there is a causal or correlational relationship between fracking activities and seismic activities (Holland 2011, p. 25).
One example for seismic activities (assumingly) caused by fracking are earthquakes in the United Kingdom near the city of Blackpool, where in 2011 after Cuadrilla Resources had conducted hydraulic fracturing, activities of magnitudes - 2.3 and - 1.5 on the Richter scale occurred. The British Geological Survey supposed that there was a connection between the exploitation of shale gas and the earthquakes, as the "epicentre of the second quake was within 500 metres of the drilling site, at a depth of 2 kilometres" (Marshall 2011).

[21] Shale gas is natural gas and does therefore belong to non-renewable resources, which emerged from the rotting of prehistoric plants and animals between rocks under certain pressure, temperature and time conditions (U.S. Department of Energy 2015).

[22] When burning natural gas for heat production, carbon-dioxide is set free, which is a greenhouse gas. Furthermore methane, as the main component of natural gas, is itself a greenhouse gas. Nevertheless, carbon-dioxide emissions when burning natural gas are calculated to be half of the CO_2 emissions when burning coal and 75% those of oil (Demirbas 2010, p. 68)

[23] Natural gas usually consists of more than 90% methane. It also includes small amounts of ethane, propane, butane and other hydrocarbons. Nitrogen and carbon-dioxide may also be contained. (Demirbas 2010, p. 58)

Although researchers come to differing results[24] when investigating fracking and background conditions in Europe and the United States[25], it was found that the total shale gas use does emit less greenhouse gases than generating electricity from coal (Forster, Perks 2012, p. 67).

Furthermore, environmental risks turn into social risks, if the area where fracking should be employed as technique has a high population density. Aspects like noises and traffic during the exploitation process and the destruction of landscapes can affect people in an additional way. (MKULNV 2012)

Generally stated, non-conventional gas exploitation is considered to be "more invasive, involving a generally larger environmental footprint" (IEA 2012a, p. 19) than conventional exploitation. However, the mentioned environmental concerns should only give an idea on the critiques argued by this political camp, as a detailed analyses would go beyond the scope of this paper.

2.3. Profitability

Fracking must be financially profitable. If it was not, it would hardly be imaginable why companies and states should have an interest in its development. Profitable does not imply that shale gas exploitation has to be cheaper than conventional natural gas production, but as conventional reserves decrease, the price of exploitation has to be acceptably low. The typical depth for shale gas production is less than 3,500m, which is "more due to well costs than for geological reasons" (Gény 2010, p. 5). The following components contribute to the final costs of non-conventional gas production: "capital costs, operational costs, transportation costs, and

[24] Publications arguing against the significance of environmental risks:

- KPMG Argentina conducted a research, emphasizing the benefits of shale gas exploitation, only mentioning that eventual risks have to be handled, but focusing on the profitability of shale resources for the country (KPMG Argentina 2014)
- In 2013 the American Petroleum Institute released a fact sheet with "10 Points Everyone Should Know" about shale energy. Industries are obliged to stick to laws and guidelines to prevent risks for the environment. Risks like water contamination are rejected, as well as a causality between fracking and seismic activities, which makes fracking a viable energy source (API 2013)
- In a study of the U.S. Department of Energy and the National Energy Technology Laboratory, it had been examined that there was "no detectable migration of gas and fluids from the Marcellus Shale to the overlying Upper Devonian/Lower Mississippian gas field" (Hammack et al. 2014, p. 46), which may refute the concern of frack fluids migrating to upper drinking water reserves. Also microseismic events were absorbed by a limestone layer between the wells (ibid.).
- A report by the Polish Kosciuszko Institute from 2011 claims many environmental concerns to be overestimated by ignoring and emotionalizing scientific research. The benefits of gas consumption to halt climate change exceed the risks of mostly unproven environmental constraints (Albrycht et al. 2011, pp. 35–41).

[25] In addition to geological differences of shale rocks in the United States and in Europe, a distinct procedure of political action could be surveyed: while conducted fracking activities in US states like Pennsylvania or Texas were followed by new legislation, European institutions and countries tried to work on legislation before a commercial exploitation of shale gas could be pursued (Boersma, Johnson 2012, pp. 572–574).

taxes and royalties" (IEA 2012a, p. 71). As these elements are mostly tied to regional conditions, a general statement on total costs is difficult to deliver.

The production costs in the United States are e.g. assumed to be about 50% lower than in Europe, where "a range of break-even costs between $5/MBtu [Million British Thermal Units] and $10/MBtu" (IEA 2012a, p. 72) can be found. Interestingly enough, the costs of conventional and non-conventional gas production are estimated to be similar because of a shift of conventional exploitation activities to areas which are difficult to access (ibid.). Applying these numbers to the gas price (see Figure 2 and 3) in April 2012, on its minimum point of $1.9270, the production would not have been profitable for Europe. But, according to the Federal Institute for Geosciences and Natural Resources, "gas in Germany was more than three times as expensive as in the USA at the end of 2012" (BGR 2013, p. 26) which would theoretically move it into the frame between $5-10/MBtu, when multiplying $2 by minimum three times.

Figure 2 Price of Natural Gas (NG: 1) from 2010 to 2015 http://www.bloomberg.com/quote/NG1:COM

In general, there is a higher incentive to develop new technologies if the chance to sell the product is economically more profitable. Like this, Medlock III from the James A. Baker Institute for Public Policy stated that "higher gas prices will induce more production, while lower prices will inhibit growth" (2015, p. 6). Referring to the graph below, there is an increasing tendency of the natural gas price, which would be favoring further investments in fracking activities.

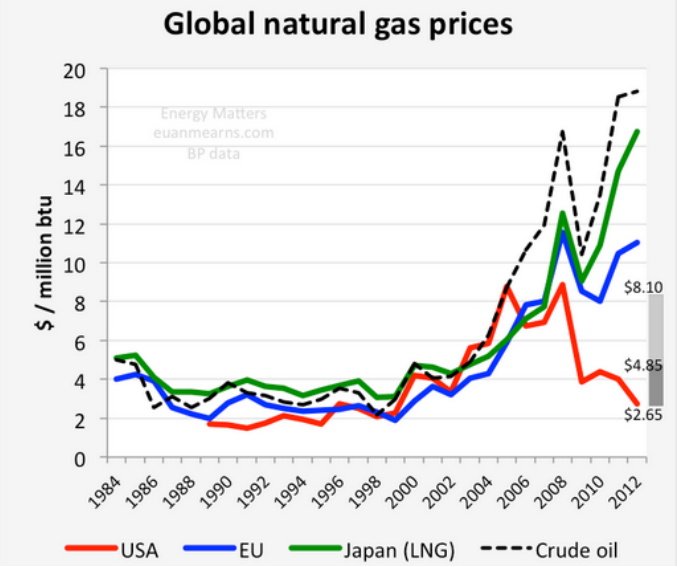

Figure 3 Global Natural Gas Prices (Mearns 2013)

At the moment, the hydraulic fracturing technique is conducted with huge amounts of water which is "the simplest and most cost-effective solution to fracture a rock formation" (Gandossi 2013, pp. 8–9) but depending on the region and the availability of resources there are also considerations to employ foams etc. as 'frack fluids'. With the region also the productivity of a well varies, as "Shale resources are categorized into 10 tiers, with tier 1 being the most productive and tier 10 being the least productive part of the shale" (Medlock III 2015, p. 5). Normally, the productivity of a shale gas well decreases during the first year of exploitation for about 70-90% (Gény 2010, p. 5).

A universal conclusion on the profitability cannot be drawn as costs for exploitation and prices of gas vary significantly depending on each well and the different countries or world regions.

2.4. Energy Security

Energy Security has been defined in various papers, e.g. in the Green Paper of the European Union from 2000[26] or by Jansen and Seebregts from 2010[27]. In the beginning of this work, the definition of Yergin (1988) was introduced (see Chapter 1) and will be referred to in the next paragraphs.

[26] There are several conceptualizations of energy security with differing emphases, e.g. a Green Paper – "Towards a European strategy for the security of energy supply" of the European Commission determined that the "strategy for energy supply security must be geared to ensuring, for the well-being of its citizens and the proper functioning of the economy, the uninterrupted physical availability of energy products on the market, at a price which is affordable for all consumers (private and industrial), while respecting environmental concerns and looking towards sustainable development" (European Commission 2000).

[27] A more detailed definition has been given by Jansen and Seebregts, defining energy security "as a proxy of the certainty level at which the population in a defined area has uninterrupted access to fossil fuels and fossil-fuel based energy carriers in the absence of undue exposure to supply-side market power over a period ahead of 10 years or longer" (Jansen, Seebregts 2010, p. 1654).

Meanwhile “national values and objectives” (Yergin 1988, p. 111) were not supposed to be threatened in this definition, the IEA adds the terms of long-term and short-term energy security, the prior is similar to Yergin’s preferences and is about “timely investments to supply energy in line with economic developments and environmental needs” and the latter about “the ability of the energy system to react promptly to sudden changes in the supply-demand balance” (IEA 2015). A more economic and at the same time social definition of energy insecurity has been given by Bohi, Toman and Walls, who define of energy insecurity, “as the loss of welfare that may occur as the result of a change in price or availability of energy’’ (Bohi et al. 1996). Welfare is meant here as an economic parameter, but when applying it in the sense of well-being, it underlines the importance of energy security for people.

According to Winzer (2012), energy security can be threatened by three different risks, which are of natural, human or technical nature, the “human risk of geopolitical disruptions”(2012, p. 37) being most relevant, as it is incalculable and may e.g. result due to demand fluctuations, wars or political instability (ibid.). As politics are also man-made, they can be the determining variable for the inclusion or exclusion of shale gas production into the state’s energy supply. Assuming that shale gas could achieve more energy security for states, the human risk would be the setting of political priorities which do not favor fracking. It is assumed that threats to energy security can appear on all levels and local and global incidents may have an influence, but final decisions about fracking will be made on the national level (ibid, p.38).

The relevance of these definitions for this research emerges from the controversy of fracking and its environmental impacts while taking a demand for (energy) security into account at the same time. If national states focus on environmental protection as one of their national aims or environmental needs, the exploitation of shale gas might not be the most suitable alternative. When relating to economic developments, states might consider it as an additional income source and also when applying the short-term definition of the IEA, an additional energy source could bypass times of political insecurity. The autonomous production of shale gas could reduce dependence in terms of decreasing the need for exports and reduce physical vulnerability[28] in terms of diversifying energy sources (cf. Marín-Quemada et al. 2012, p. 30).

“The ‘sweet spot’ that balances security, economic, and environmental interests” (Andrews 2005, p. 24) can only be achieved when all these interests have equal priorities for the state, which according to Andrews is not very likely to happen (ibid). He further argues that an integration of renewable energy sources in national energy matrixes could be an advantage as it is a very decentralized and therefore a secure and flexible energy source for states (Andrews 2005, pp. 18,21). Additionally, negative externalities like environmental pollution, which may result in the energy sector could be reduced by these policies. Like this, energy security is not only the exploitation of a maximum of resources but also to take externalities or public goods

[28] The degree of physical vulnerability is explained by “the geographic concentration of supply and the flexibility of the supply infrastructure” (Marín-Quemada et al. 2012, p. 30).

into account (ibid, p.21). On the other hand, Marín-Quemada et al. argue that the environmental variable should not be part of the (operational) definition of energy security, as the protection of the environment and the provision of energy security are mutually dependent (2012, pp. 28–29). Engagement in energy security might favor fossil resource consumption and an engagement in environmental protection might lead to energy insecurity (ibid.).

If renewable energies are excluded from considerations, fossil reserves and resources are expected to be sufficient for the next twenty years, but the price for the exploitation of additional resources cannot be specified exactly (see graph below, BGR 2013).

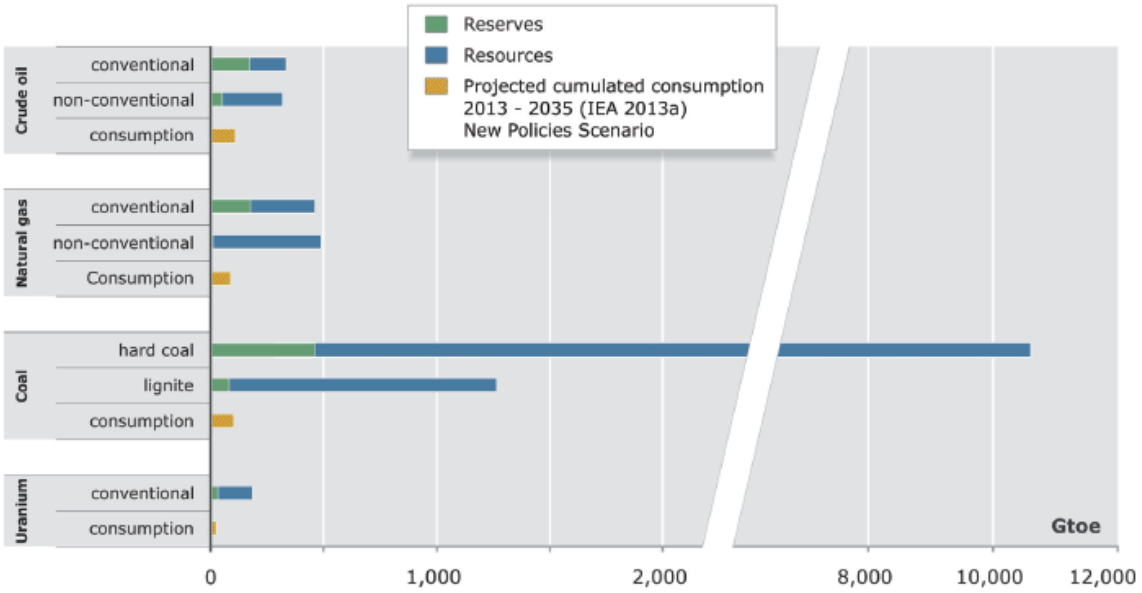

Figure 4 Supply situation for non-renewable energy resources at the end of 2012 (BGR 2013, p.35)

In the world's energy consumption, fossil fuels are still most important with a share of 88%. Gas was on the third position of energy sources (23.8%), after oil (34.8%) and coal (29.4%) (Marín-Quemada et al. 2012, p. 8). Its relevance for energy security can be underlined hereby, particularly when referring to the definition of Yergin, demanding "adequate, reliable supplies of energy" (2003, p. 111). When amounting for 24% of total world's primary energy consumption, the adequacy of gas as medium to provide energy security can be assumed. Especially Europe is well connected to both a pipeline system for natural gas and LNG terminals (liquefied natural gas) which gets it into "a relatively comfortable position in principle" (BGR 2013, p. 26). Europe also has own gas resources which amounted to 21 trillion m^3 in total with shale gas representing the biggest fraction with 14 trillion m^3 in 2013 (BGR 2013, p. 39). Particularly when referring to the adequacy of an energy source to provide energy security, the advantage of shale gas is its suitability for end use, as it can be used in industry, private houses and for the production of energy after relatively short refining processes (Speight 2013, p. 20).

2.5. European guidelines

Until now there is no comprehensive binding legislation in the European Union referring explicitly to shale gas exploitation. It is still in the responsibility of Member States to decide in favor or against the implementation of fracking in their country (European Commission 2014a, pp. Issue 1). The latest activity of the European Commission was the release of a recommendation on January 22nd, 2014 advising states among others to implement risk assessment procedures, taking technical and environmental science into account (paragraph 5), to surveil companies and their operations (paragraph 9), to encourage companies to work responsibly with chemicals (paragraph 10) and to monitor processes and report results to the European Commission (paragraph 11,16) (European Commission 2014a).

Beforehand, both the European Parliament and Commission had published several reports and studies dealing with the relevance of shale gas resources for Europe, the extent of environmental risks and the possible impact of shale gas for the economy.[29]

Furthermore, there have been legislative progresses on environmental or industrial issues, which can partly be applied to shale gas production. In 1985 the "Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment" was released later known as the EIA Directive (Environmental Impact Assessment). This directive was amended five times, the latest version is Directive 2014/52/EU, which is supposed to increase "the level of environmental protection, with a view to making business decisions on public and private investments more sound, more predictable and sustainable" (European Commission 2012). In an annex document of 2011, EU officials stated that "both the exploration and exploitation of unconventional hydrocarbons fall within the scope of the EIA Directive" (European Commission 2011).

Additionally, European law such as e.g. the Mining Waste Directive (2006/21/EC), the Water Framework Directive (2000/60/EC) or the REACH (Regulation on the registration, evaluation and authorization of chemicals (1907/2006/EC) include relevant aspects which can be applied to the fracking technique.

In February 2015, a questionnaire of the European Commission was answered by the Member States to collect similar information about fracking activities in the member states with the purpose to elaborate further legislation.

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[29] Documents available are e.g.

- "Final Report on Unconventional Gas in Europe" TREN/R1/350-2008 lot 1. Philippe & Partners on 11/08/2011
- "Climate impact of potential shale gas production in the EU. Final Report." Report for European Commission DG CLIMA. AEA/R/ED57412 on 07/30/2012
- "REPORT on the environmental impacts of shale gas and shale oil extraction activities (2011/2308(INI))" of the Committee on the Environment, Public Health and Food Safety. Rapporteur: Bogusław Sonik, on 09/25/2012
- Study of "Macroeconomic impacts of shale gas extraction in the EU". European Commission DG ENV— Ref: ENV.F.1/SER/2012/0046r in 03/2014

A communication document from the European Commission to the Parliament, called “European Energy Security Strategy”, from May 2014, states that

> *“Producing oil and gas from unconventional sources in Europe, and specially shale gas, could partially compensate for declining conventional gas production provided issues of public acceptance and environmental impact are adequately addressed” (European Commission 2014b, p. 13).*

The document was accompanied by the “In-depth study of European Energy Security”, providing details about the member states’ and the EU’s “sources, diversity, dependency and cost of energy” (European Commission 2014c, p. 3).

Concluding, it can be stated that even if there is no explicit legislation or position of the EU, generally a receptive attitude towards the development and integration of fracking technologies in the member states can be detected. However, there is an interest of the European Commission to investigate energy security in order to provide a comprehensive solution in the future (European Commission 2014b, 2014c). For this paper the absence of concrete EU legislation offers the possibility to take a closer look on the handling of the topic by Germany and Poland as European member states.

3. Germany

3.1. Energy Matrix and Shale Gas Resources

Germany's energy consumption is quite diverse. As mentioned before, oil, coal and gas represent the most important energy sources in the world (Chapter 2.4). In 2011, total primary energy supply (TPES) in Germany amounted to 311.8 Mtoe (million tonnes of oil equivalent), which was 7.4% less than in the year 2000 (IEA 2013, p. 19). In 2014, TPES increased modestly up to 313.8 Mtoe (BMWI 2015a). Natural gas accounted for 22.3% in 2011 and for 20.4% in 2014 and but according to German officials, there is a trend to augment up to 25% of TPES until 2030 (BMWI 2015a; IEA 2013, pp. 19,21). In the same period of time, "renewables are expected to make a significant shift in the energy mix, up to 33.2% of the TPES in 2030" (IEA 2013, p. 21). Due to a decision made after the nuclear reactor accident in Fukushima, Japan, nuclear energy should not be produced anymore after the year 2022 in Germany[30], so that the 8.1% of energy supply coming from nuclear energy will have to be substituted by one of the remaining energy sources or through energy imports. In 2011, the domestic energy production amounted to 124.2 Mtoe (IEA 2013, p. 19).

% of Total Primary Energy Supply	**2011** (IEA 2013)	**2014** (BMWI 2015a)
Mineral Oil	32.7%	35%
Coal (black and brown)	24.8%	24.6%
Natural Gas	22.3%	20.6%
Nuclear Energy	9%	8.1%
Renewable Energy	11.3%	11.1%

Table 1 Components of TPES in Germany in 2011 and 2014 (own table; IEA 2013, BMWi 2015a)

Up until now, shale gas is not exploited commercially in Germany (UBA 2014, p. 3), but recoverable resources are "estimated as ranging from 0.7 to 2.3 trillion m^3" while IEA estimations were 0.48 trillion m^3 in 2013[31] (BGR 2013). In comparison, German natural gas reserves were 175 billion m^3 in 2011 and 351 billion m^3 in 1990, which made it possible that one sixth of natural gas supply was produced in Germany in 2011 (IEA 2013, p. 69). In 2012, German production of natural gas amounted to 7% of total EU production, making the country the third biggest producer in the EU (European Commission 2014c, p. 21). Nevertheless, the net import dependency on natural gas amounted for 86.8% of total primary energy consumption in Germany in 2013 (BMWI 2015a).

[30] The Germany nuclear phase-out ("Atomausstieg") was introduced to prevent further reactor accidents. All German nuclear plants will be decommissioned until 2022. (Bundesregierung 2015)

[31] Different formations were examined in both studies, but when comparing exactly the same formations, BGR estimations are also around 0.4 trillion m^3 (BGR 2013, p. 39).

3.2. National Legislation

Until now, there is no legal basis explicitly regulating the shale gas exploitation in Germany. The Federal Mining Act, which was adjusted in 2013, provides an implicit basis (BDI 2013, p. 9; Deutscher Bundestag 8/13/1980). In §3 (3), natural gas is named "bergfrei" which makes it property of the state and its exploration requiring a permission, and its production a license (§6) (Deutscher Bundestag 8/13/1980).

Recently, on March 7th of 2015, a draft law was presented by the Minister for the Environment, Dr. Barbara Hendricks and the Minister of Economy, Sigmar Gabriel, proposing a comprehensive regulation of further fracking activities in Germany (FAZ 2015, April 1st). Many members of parliament from the governing party as from the opposition favor stricter regulations for environmental protection (ibid.). Although the law has not been passed yet, it is the newest development in German legislation[32].

Substantially, the draft law contains a general prohibition of fracking activities in areas where water is extracted for drinking water supply, in water protection areas and in those areas with curative waters and also for the underground storage of reservoir waters[33]. Furthermore, the threshold of 3000m depth is mentioned, prohibiting any fracking activities above this depth. In special cases, testing activities may be granted in areas not belonging to the above mentioned protected zones. In order to achieve a testing license, a committee of experts has to be involved, consisting of six members from German administration and different research institutes. This committee should be able to distribute testing licenses on the premise that all environmental concerns have been taken into account and are regarded harmless. Furthermore, exploration activities have to suit national and regional law and frack fluids have to be proven harmless according to a national classification. Under certain circumstances and if the fulfilment of all conditions has been confirmed by the committee of experts, licenses for commercial exploitation can be granted. (Deutscher Bundestag 2015b, April 23rd, p. 14).

After the presentation of the draft law, the Federal Council of Germany proposed some amendments which in turn were answered by the Government. The amendments suggested an even stricter draft law, containing the general prohibition of fracking and also testing activities (Deutscher Bundestag 2015c, May 20th, pp. 10,14). The Government rejected this amendment as well as the one to delete the 3000m depth as criterion for any licenses, as it is argued to give the legal certainty to distinguish between conventional and unconventional fracking (ibid, p. 11, 14). The underlying opinion of the Government, not to prohibit a new technology completely without exceptions, was declared (ibid.).

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[32] Originally, the draft law was supposed to be passed on July 3rd, 2015, but since it was discussed too controversially in the German Bundestag, the vote has been postponed until the end of the summer break for parliamentary sessions (FAZ 2015, June 30th).

[33] Technically, the areas excluded from fracking activities are: nature reserves, national parks, Natura 2000 areas, water protection areas, natural lakes and reservoirs and medicinal spring protection areas. Additionally, the federal states may extent the prohibited areas. The Federal Nature Conservation Act and the Federal Water Act include further specification on these terms. (Deutscher Bundestag 2015b)

Another relevant component in the German legislation concerning fracking activities is the "Energy Concept" from September 2010, which then provided the basis for the Energy Transition ("Energiewende"). It does not explicitly relate to hydraulic fracturing as a technology but it determines the direction of action for further German energy policies towards a renewable energy supply and environmental protection (IEA 2013, p. 26).

3.3. Analysis of the German Perspective on Fracking

German energy politics are determined by a target triangle of "security of supply, profitability and environmental compatibility" (Mükusch 2011). Referring to the research question of this paper, it has to be evaluated which of these three aspects results to be most important in the matter of unconventional shale gas exploitation. According to a definition of national interests by Glatz (2010)[34], it can be concluded that energy security is a vital interest for Germany (Glatz 2010, p. 46). Therefore it has a high priority, but as the before mentioned target triangle ("Zieldreieck") is also of high priority, a conflict may emerge in weighing e.g. environmental compatibility against security of supply or profitability (Glatz 2010, p. 46).

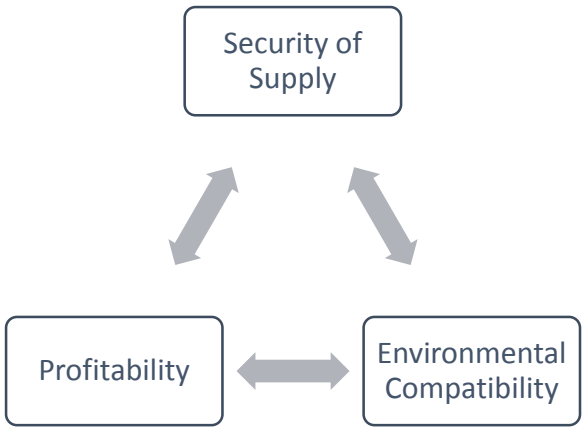

Figure 5 Target Triangle for Energy Politics (own diagram, cf. Mükusch 2011)

Applying the rational choice approach on this topic, utility maximization can be one impetus for states to act and it can be achieved by weighing *utility* against *probability* and *costs* of a decision (Stocké 2002, p. 9). The *utility* to employ fracking in Germany would be to reduce the country's dependency on imports, as only a sixth of national gas consumption is provided autonomously (BGR 2013, p. 25; IEA 2013, p. 69). Following the argumentation of the Federal Environmental Agency, the exploitation of national shale gas resources will not contribute significantly to the German security of supply as the accessibility is limited and efficiency enhancement and the advancement of renewable energies are more likely to reduce the import

[34] National interests can be vertically arranged, whereby vital interests represent highest priorities, very important interests are one level below and are followed by important interests and less important interests Glatz 2010, pp. 35–37.

dependency of the country (UBA 2014, p. 4). Furthermore, these measures would help to reduce Germany's greenhouse gas emissions and thus to engage in climate protection (UBA 2014, p. 4).

Here it becomes apparent that a reduction of dependency is considered important by German officials but the exploitation of shale resources is not the preferred way. Diversification is the key strategy to improve energy security in Germany: both an advanced portfolio of energy sources from renewable sources as well as the extension of the circle of trading partners are considered a viable alternative for Germany (Mükusch 2011, pp. 125–126; UBA 2014, p. 4). Another aspect of high utility would be the implementation of a strict law, banning fracking from German agendas, as environmental protection would be quasi secure.

In contrast to this argumentation stands the German industry which is an important influence on national interests in a country whose exported goods were worth €1,134 billion in 2014 (Statistisches Bundesamt 2015). The Voice of German Industry (BDI) argues in favor of an engagement in the development of hydraulic fracturing technology as for an industrial country like Germany it is of great importance to gain technical expertise and to participate in the global competition of this technology (BDI 2013, p. 7). Furthermore, Germany is considered an adequate place to enhance technologies further in order to achieve techniques to exploit shale gas without polluting the environment (ibid.). Utility is thus differently determined by actors but since the primary decision on the implementation of fracking is made by the government, until now the industry has not achieved its goal of an explicitly affirmative German national interest expression towards fracking.

Currently, the regions in Germany where shale gas resources are expected, are located in the North German Basin, including the area of the Islands of Hiddensee, Rügen and Usedom. Furthermore, there are the southern Molasse basin and the Upper Rhine Rift in the southwest of Germany which are likely to contain shale gas resources (see figure below) (FAZ 2015, April 4th; BGR 2013, p. 37).

Figure 6 Areas in Germany were fracking could be profitable: Grey stands for areas where shale gas can be expected from a geological perspective, green marks granted exploration licenses (FAZ 2015, April 4th)

Later on, *probability* is relevant in the rational decision making process. As mentioned before, the accessibility of resources cannot be clearly determined from a theoretical perspective (UBA 2014, p. 4). Additionally, the probability for a change in prices in the case of German engagement in shale gas exploitation is not expected to be significant in a short-term perspective (ibid.). Therefore prices could only cause a small increase of probability for the success of the decision. In contrast, the probability of avoiding environmental damages by prohibiting hydraulic fracturing is significant, so to decide against fracking would be a "safe" decision for the German government.

There are different kinds of *costs* that have to be acknowledged when considering shale gas production in Germany: exploration needs time and time costs money, research activities cost money, surveillance costs money and environmental pollution is a special kind of costs. On the other hand there is the above mentioned risk not to keep pace with the global technology development and to be dependent on energy imports (BDI 2013).

Currently, uncertainty represents a huge cost for Germany as environmental risks cannot be reliably confirmed or denied (MKULNV 2012) which makes a cautious handling of further decisions recommendable. If the draft law of April 2015 will be passed similarly to the current version, the uncertainty of German policy makers can be identified: on the one hand the law is quite strict, principally prohibiting the exploitation of shale gas but on the other hand it leaves a room to apply for testing licenses and even exploitation licenses if a committee of experts decides in favor of it (Deutscher Bundestag 2015b, April 23rd).

The German National Academy of Science and Engineering (acatech) argues against the prohibition of fracking. Ignorance often leads to the false assumptions in discussions, such as the environmentally hazardous character of fracking fluids, which according to acatech only includes additives approved as 'low' on the water hazard classification (acatech 2014, p. 8) or to the confusion of drinking and formation water (ibid, p. 7). The cost of these assumptions are costs for the non-applicability of fracking for geothermal energy and the stop in technological development (ibid, p.5).

For acatech, fracking should therefore not be forbidden as there is not enough proof of the harming character of the technology. An independent monitoring committee and mechanism should rather be established to conduct further research and development on the technique with best technical knowledge and transparent working structures (ibid, p.10). Likewise, the company Wintershall, as Germany's biggest oil and gas producer, demands a reliable legal framework to conduct hydraulic fracturing in Germany, as until now 300 "fracs"[35] have been realized in Germany with conventional gas without the smallest accident (Wintershall 2015). Furthermore, and with reference to the legislation uncertainty, €1 billion of investments in research and exploration is currently postponed and jobs could get be in danger (Wintershall 2015).

The costs for licensing, monitoring, general administration etc. that are contained in the draft law, add up to a two-digit million amount per year, specified in the draft law (Deutscher Bundestag 2015b, April 23rd, pp. 16–20).

Preferences are usually set if costs are low, the probability is perceptible and the utility is high. German preferences will therefore strive to meet these criteria, assuming a rational behavior. The preferences have to be analyzed with regard to past decisions as in environmental politics current decisions depend a lot on former decisions (Böcher, Töller 2012, pp. 153–154). Due to the fact that Germany did not conduct unconventional gas exploitation through fracking to date, costs must have predominated the possible utility.

As mentioned before in the context of legislation, Germany made a pioneering decision with the implementation of the Energy Concept in 2010. The purpose of the energy concept itself is the transition of Germany

> *"to become one of the most energy-efficient and greenest economies in the world while enjoying competitive energy prices and a high level of prosperity […] [including a] a high level of energy security, effective environmental and climate protection and the provision of an economically viable energy" (BMWi, BMUB 2010, p. 3)*

In concrete numbers, the goals of this concept are "to achieve a 40% cut in GHGs [greenhouse gases] by 2020, 55% by 2030, 70% by 2040 and between 80% and 95% in 2050, compared to 1990 levels" (IEA 2013, p. 26). The ambition visible in this concept gives an insight into the

[35] Fracking was applied to conventional gas reserves, mainly the federal state of Lower Saxony in the time between 1961 and 2011. (FAZ 2015, April 4th)

status of the environmental variable in Germany. Although energy security and prosperity should be achieved, there is a clear focus on the way how to achieve it, namely the reduction of energy consumption (efficiency) and the pursuit of environmental protection. Both can be accomplished e.g. through improving technologies and diversifying renewable energy sources (UBA 2014, p. 4). The nuclear phase-out represents the idea of a providing a stable energy supply through decommissioning nuclear energy plants stepwise but at the same time making a consequent decision against this (environmentally) risky energy production. For Germany, nuclear energy was an important energy carrier, as it enabled the "reduction of dependencies and the prevention of supply shortages"[36] (Mükusch 2011, p. 117, translation myself).

The fact that shale gas could be an energy source for the transition, can be found in a statement by the Leopoldina academy which was given after the accident of Fukushima. Due to the extension of natural gas power stations, one of the short-term recommendations for the supply of energy reads that "research efforts should be made, to develop unconventional natural gas sources in Germany, such as coal bed methane and shale gas"[37](Leopoldina - The German National Academy of Sciences 2011, p. 20, translation myself).

Looking at security of supply, "currently only limited energy security is present in and for Germany"[38] (Mükusch 2011, p. 210, translation myself) because the shortage of energy supply could be compensated through stored reserves for a short period of time. On a long-term perspective a more comprehensive energy approach ("Vernetzte Energiesicherheit") would be needed to combine economic, societal, environmental, security, and foreign perspectives (ibid, p. 218). The Energy Concept of 2010 does at least connect environmental or climate issues with economic aims (ibid, p. 211).

Another evidence of the prioritization of Germany authorities is the study released by the Ministry for Climate Protection, Environment, Agriculture, Conservation and Consumer Protection of the State North Rhine Westphalia, conducting research on former fracking exploration activities and concluding the unpredictability of risks caused by fracking, as geographic situations vary in each case and there is still a lack of literature concerning the impact on seismic activities, the continuance of frack fluids in the ground etc. (MKULNV 2012, pp. 58–62).

[36] Original wording: "Kernenergie ist einer der wirtschaftlich verfügbaren Energieträger in Deutschland, der zur Reduzierung von Abhängigkeiten und Verhinderungen von Versorgungsengpässen von versorgungspolitischer Bedeutung ist" (Mükusch 2011, p. 127)

[37] Original wording: „[…] sollten Forschungsanstrengungen unternommen werden, unkonventionelle Erdgasquellen in Deutschland zu erschließen, wie etwas Kohleflözgas und Schiefergas" (Leopoldina - The German National Academy of Sciences 2011, p. 20)

[38] Original wording: "Derzeit herrscht nur eingeschränkte Energiesicherheit in und für Deutschland" (Mükusch 2011, p.210)

The recommendation for action reads:

> *"We recommend not to agree to the exploration and the production of unconventional natural gas deposits through fracking in North Rhine-Westphalia as long as certain conditions are not fulfilled"*[39] *(MKULNV 2012, p. 63, translation myself)*

The mentioned conditions are e.g. solutions for the treatment of waste from fracking residues, the implementation of reliable monitoring procedures and a transparent declaration of frac additives (ibid, p.63).

Germany has a leading position in environmental politics (Böcher, Töller 2012, p. 85) and Sigmar Gabriel, the Federal Minister for Economic Affairs and Energy, has recently underlined Germany's technological advance in solar and wind energy production (Schmidt-Mattern 2015, May 11th). With regard to the national prioritization of climate protection it can be assumed that Germany strives to keep its credibility in moving renewable energies forward, which would be intervened by a commitment to the exploitation of shale gas. Often there is insecurity in environmental politics as its purpose is to protect people and nature against potential damages but decisions are made with the scientific knowledge available at that moment which might not be thorough (Böcher, Töller 2012, p. 93). A problem with the environment as a public good is that the benefit of its protection is prevalent for the whole society but the costs have to be borne by a smaller group (Böcher, Töller 2012, pp. 90–91). Germany tends to forbid the fracking technique as in studies conducted by the BGR (2013) or MKULNV (2012), environmental risks cannot be excluded but are expected to be likely to happen. Like this, the current draft law, described above, will cause costs for companies which will nearly be unable to use fracking in Germany but guarantee security to the society in case of the harmfulness of the technique.

Applying rationality to environmental decisions, voters are likely to vote in favor of environmental regulation as costs in form of damages would have to be burdened by the society and politicians act rationally as regulations and binding laws are visible outputs of their activity and commitment (Böcher, Töller 2012, p. 100). In the matter of the current draft law this seems a relevant aspect, as the two ministers who proposed it are pushing it forward while organizations like the German Federation for Environment and Nature Conservation (BUND) are objecting on the law which in their opinion is an enabling law ("Ermöglichungsgesetz") for fracking (BUND 2015, April 1st). BUND criticizes the law as being motivated too much by leaving the possibility for fracking for the industry and not implementing a general prohibition (BUND 2015, April 1st).

As explained by Stocké (2002), decisions can be made under incomplete knowledge but with best conscience. This could be an explanation for people in Germany engaging against fracking (FAZ 2013, May 5th), because they have the intention of acting ethically, however possibly without being informed adequately about the opposed scientific findings in favor of fracking

[39] Original wording: "Wir empfehlen, der Erkundung und Gewinnung unkonventioneller Erdgas-Lagerstätten mit Fracking in NRW solange nicht zuzustimmen, bis bestimmte Voraussetzungen erfüllt sind" (MKULNV 2012, p. 63).

(e.g. German National Academy of Science and Engineering (2014)). In total there are 2,200 communities in Germany speaking against fracking activities in their area with demands ranging from a general prohibition to more research as a condition for further activities (BUND).

Concluding from a rational perspective and related to the German target triangle of (1) *security of supply,* (2) *profitability* and (3) *environmental compatibility* (Mükusch 2011, p. 116), the implementation of fracking would only make sense if all of the three aspects were more or less fulfilled and costs of the shale gas exploitation would be low. Neither is *security of supply* assumed to be met by making use of fracking in Germany (UBA 2014, p. 4), nor is the *profitability* of the technique expected to be significant in Germany as production is very expensive in Europe and the accessibility to resources varies (IEA 2012, p. 72). At least there is *environmental compatibility* as criterion to be fulfilled which according to present knowledge cannot be guaranteed due to a lack of reliable data (MKULNV 2012, pp. 58–62).

German preferences are assumed not to match with the fracking technology when employing a rational approach as uncertainty and costs predominate over possible benefits. Nevertheless, preferences are not static and if the prevailing conditions change, preferences may adapt (Dehling, Schubert 2011). For Germany's current attitude towards fracking this means that a change in its international relations, in the European Union or with its trading partners might cause a modulation of policies. Coming back to Walt (1999), in security studies the behavior of others can influence rational decisions of states and therefore it cannot be ruled out that Germany will revise its attitude towards fracking if a serious threat in energy security appears.

3.4. Interim Conclusion of Country's Priorities

The selection of aspects shown above give an insight into Germany's attitude towards the technology of hydraulic fracturing and how this can be seen in a wider context of the country's energy strategy. It can be concluded that fracking is mainly rejected by the government and that it has not been acknowledged as an essential way to improve energy security (cf. Deutscher Bundestag 2015a, March 7). The rejection mainly results out of the uncertainty of environmental risks which could not be proven as sufficiently-harmful yet. The environmental costs result thus to be incalculable, both in a technical and a political way. As the protection of the environment has been declared a key priority in the Energy Concept of 2010, shale gas exploitation is not compatible with a sustainable energy production approach. Due to shale gas' nature of being a fossil energy carrier, whose consumption would contribute to the greenhouse effect and thus to climate change, it does not suit the environmental approach of the Energy Concept. Assuming that a prospective law will not prohibit all kinds of testing activities on fracking, companies will have to prove the harmlessness of the technique to make it a considerable alternative in the future. Nevertheless, according to current knowledge the protection of the environment through the establishment of renewable energy production has a higher priority for Germany, as risks are not completely determined and therefore constitute uncertain costs of environmental damage. The factor of Germany being a leader in energy transition might also be encouraging to decide against fracking to maintain international credibility.

4. Poland

4.1. Energy Matrix and Shale Gas Resources

Poland's energy mix is based on fossil energies with a significant share of black and brown coal contributing to the country's supply (IEA 2011b). In 2012, total primary energy supply (TPES) amounted to 97.85 Mtoe, which is comparable to the amount of circa 95 Mtoe in 2009 (IEA 2011b, p. 18). Net imports in Poland came to 30.92 Mtoe in 2012 which shows that Poland imports less than half of the amount of TPES (ibid.) Although coal is the main energy resource consumed in Poland with a share of 53% of TPES, natural gas is the third most important energy source with 14% of TPES, with a tendency to increase (IEA 2011b; IEA 2015). Total gas consumption amounted to 16.3 billion m^3 (approx. 13.5 Mtoe) in 2012 (European Commission 2014c, p. 241). In the same year, the country's own natural gas production accounted for 4.2 Mtoe in 2012 (IEA 2011b; IEA 2015), whereby Poland is dependent on the import of two-thirds of total natural gas demand, which consist for 80% from Russian gas (IEA 2011b, p. 26; GUS 2014, p. 44). For the next years, natural gas demand is expected to increase with an annual average growth rate of 2.3% though it is predicted by the Energy Policy of Poland until 2030 (EPP 2030), "to increase by 28% in 2020 and by 52% in 2030, compared with the 2009 level" (IEA 2011b, p. 18).

% of Total Primary Energy Supply	**2009** (IEA 2011b)	**2013** (GUS 2014)
Mineral Oil	25%	23%
Coal (black and brown)	55%	53%
Natural Gas	13%	14%
Renewable Energy	7.3%	-
Others	-	9%

Table 2 Components of TPES in Poland in 2011 and 2014 (own table; IEA 2011b, GUS 2014)

In the EPP 2030, the integration of renewable energies and a diversification of the energy mix including the exploitation of shale gas and the establishment of nuclear energies is targeted (KAS 2014, p. 43; Ministry of Economy 2009, p. 4).

The estimations of shale gas resources in Poland differ significantly. The U.S. Energy Information Administration estimated unproved shale gas resources at 4.19 trillion m^3 (EIA 2013, p. 6) while the International Energy Agency calculated unconventional gas reserves between 1.4 and 3 trillion m^3 (IEA 2011b, p. 100). According to the German Federal Institute for Geosciences and Natural Resources, Polish resources were expected to amount between 0.35 to 0.77 trillion m^3 by the Polish Geological Survey in 2011, while the U.S. Geological Survey estimated them to amount only 0.038 trillion m^3 (BGR 2013). Although these numbers vary, Poland's shale gas resources are very relevant and comparing IEA estimations, they are significantly higher than e.g. German resources (0.48 trillion m^3 in 2013, (IEA 2013).

First drilling activities were conducted in 2010, since then "70 shale gas exploration wells, including 16 directional/horizontal and 54 vertical ones, have been completed in Poland" (PGI, NRI 2015). In general, resources were located very deep which made the production more expensive than it was anticipated (KAS 2014, p. 43).

4.2. National Legislation

The legislative basis, for fracking activities in Poland, is the Geological and Mining Law from 2011, which was amended in 2014 (Chancellery of the Sejm 2011; Chodkowski-Gyurics 2014, August 14th). This law specifies the conditions under which an applicant may apply for concessions for either the exploration or the exploitation of mining resources (listed in Art. 10). Concessions will not be granted if public interest is endangered, meaning especially national security or environmental protection (Art.29(1)) (Chancellery of the Sejm 2011).

One constraint expressed by the IEA, was a missing "supportive policy and regulatory framework" (2011b, p. 100), which could be identified as the amendment bill from August 2014.[40] The amendments enhanced the attractiveness of shale gas exploitation through easing the process of obtaining a concession for the production: after entering into force on 1st of January 2015, only the application for one license is necessary for exploration and extraction activities (Zeldin 2013; Chodkowski-Gyurics 2014, August 14th). Before starting commercial production, a so called 'investment decision' has to be granted by the Ministry of Environment, examining details of "approved production methods, the borders of mining area and the time schedule for commencing the production" (Dobrowolski, Pichet 2014, May 29th). This step represents the part of the process where the environment plays an important role and decisions can be made to protect it. In the Geological and Mining Law, an environmental inquiry had to be conducted before applying for a concession (Art.24) (Chancellery of the Sejm 2011). But, in contrast to the previous law version, since it is "faster and cheaper obtaining of environmental impact assessment reports, with such reports required only for a drilling site of two square kilometers" (Zeldin 2013). The amendment bill offers a further control mechanism for Polish authorities, containing instruments like "prequalification, triggers for concession expiration and withdrawal" (Dobrowolski, Pichet 2014, May 29th). Another change in the allocation of concessions, is its duration: before, a period of 3 to 50 years (Art 21(4)) was scheduled for exploitation activities, which has been changed to 10 to 30 years in the amendment bill (Chancellery of the Sejm 2011).

Additionally to the amendment of the Geological and Mining Law, a final draft of the Hydrocarbons Tax Law was published in 2013 by the Ministry of Finance and Ministry of Environment. This law enters into force in 2015 and makes the extraction of resources more expensive in Poland, but the taxation will finally become effective in 2020 in order to make shale gas extraction more attractive for investors before this date (Ecologic Institute & eclareon 2014, p. 12). After 2020, taxes should be paid on two levels to the Polish State. At first, there will be

[40] The amendment bill has not been published in English yet, which makes the analysis of articles the best way to access the contents.

paid a royalty of 1.5% per m^3 of produced shale gas will be paid by the operating company and at second, the hydrocarbon tax will amount "0-25% of the net profit generated in a specific deposit" additionally to regular corporate income taxes (Walawender 2014).

4.3. Analysis of the Polish Perspective on Fracking

Coming back to the target triangle for energy politics, consisting of "security of supply, profitability and environmental compatibility" (Mükusch 2011), the prioritization of the elements will be analyzed for Poland in order to answer the research question of this paper. Particularly the question of where environmental compatibility is situated in the country's values, is of high interest.

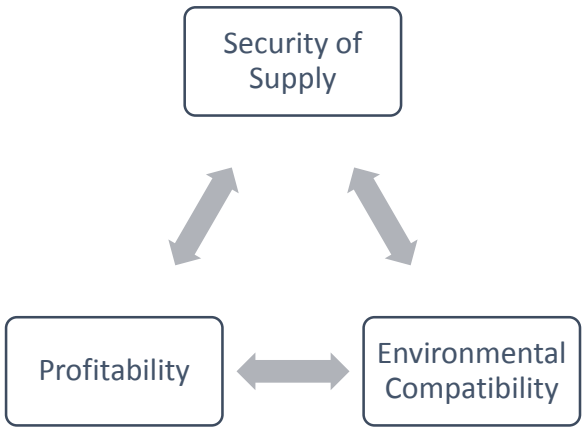

Figure 7 Target Triangle for Energy Politics (own diagram, cf. Mükusch 2011)

Applying a rational choice approach, it can be assumed that Poland's government has acted and will act in a way that suits their priorities best. For Germany, *utility*, *probability* and *costs* have been analyzed to conclude which aspects determine the maximal utility for the country.

The integration of fracking for the country's energy production can be of high *utility*. As Poland's gas consumption relies for more than two thirds on Russian gas and 90% of its oil consumption as well (BP 2014, p. 44; IEA 2011b, p. 26), an autonomous production would reduce this import dependency. This aspect contains not only a financial, but also a political reduction of dependency for Poland, which has been confronted with "oil and natural gas reserves as a political weapon" by Russia (Hakim, Zurawik 2013). Later on, adding unconventional gas resources to the energy mix implies the creation of security in terms of diversification: in the case of unavailability of another energy carrier, autonomously produced gas could help to bypass times of energy shortage.

So far, shale gas has not become a key interest in Europe, which makes it possible for Poland to "become a pioneer in the development of the shale gas sector in Europe, gaining additional state budget receipts, new workplaces and lower prices of raw materials driving the economy" (PGNiG 2015). Particularly the argument of creating employment is a benefit when considering the estimations made by PGNiG, the Polish Oil and Gas Company, of 120 to 190 thousand people possibly being involved in the next ten years "in the industry dealing with production of shale gas and related sectors (e.g. trade, steel structures, production of machines, IT)" (PGNiG

2015). Nonetheless, these numbers are opposed by predictions made in a report by The Kosciuszko Institute in 2012, stating that “the functioning of a gas mine and an underground gas storage facility does not necessarily translate into a significant improvement on the local labor market” (Albrycht et al. 2012, p. 11), whereby different experiences were made, depending on the region.

Another utile aspect of shale gas exploitation is its financial profitability. Not only companies profit from the gas production but also the state of Poland, which adjusted royalty payments and taxes for the time after 2020, when the new, before discussed, legislation becomes effective (Walawender 2014).

Furthermore, Poland is a member of the EU and therefore has to defend its ideas while sticking to binding EU legislation. For the purpose of fulfilling the European Energy Package with the so called “20-20-20” targets[41], emissions have to be reduced by 20% in 2020, based on the 1990 level (Ministry of Economy 2009, p. 4). An increase of shale gas production simultaneously with a reduction of coal consumption would favor the reachability of the EU goals, as the consumption of coal emits more greenhouse effect relevant CO_2 than the consumption of gas (Uliasz-Misiak et al. 2014, p. 75).

For a decision leading to subjective maximal utility, the *probability* of aspects to become relevant has to be taken into account. When looking at the probability of making fracking financially profitable, Polish decision makers have to take into account that most big companies have already quit their shale gas projects in Poland. In 2011, companies involved in Polish shale gas exploration were: “Chevron, Marathon Oil, Exxon Mobil, ConocoPhillips and ENI as well as smaller firms such as Talisman Energy, BNK Petroleum, Cuadrilla Resources, 3Legs Resources, San Leon Energy, RealmEnergy International, Emfesz and also Polish companies Orlen, Petroinvest, Lotos and PGNiG” (Gostyñska et al. 2011, p. 46). Chevron recently abandoned Poland in January 2015, ENI in 2014, Talisman Energy and Marathon Oil quit in May 2013, ExxonMobil in June 2012 (Reed 2015; The Economist 2013; Cienski 2014). Latest, in June 2015, ConocoPhilips decided to abandon Poland, since "unfortunately, commercial volumes of natural gas were not encountered” stated a manager of the company (Reuters 2015). These developments represent a hurdle for Poland in terms of economic profits that were hoped to be achieved easily through shale gas.

There are further uncertainties that influence the *probability* of decisions and that can turn into *costs*. Fracking of shale rock is a relatively new technology in Europe, which makes an

[41] “These targets, known as the "20-20-20" targets, set three key objectives for 2020:
- A 20% reduction in EU greenhouse gas emissions from 1990 levels;
- Raising the share of EU energy consumption produced from renewable resources to 20%;
- A 20% improvement in the EU's energy efficiency” (European Commission 2010)

evaluation of efficiency and possible constraints hard to determine[42]. Poland's decision to engage in fracking activities could therefore face difficulties if technical issues could not be foreseen.

Another uncertainty for the Polish future of fracking is the lack of binding EU legislation (see Chapter 2.5). Until now, the exploitation of fossil resources belongs to the sovereignty of the member states but if it comes to a common policy, investments realized in Poland could become ineffective in the case of a fracking-neglecting policy.

In contrast, the Polish government has done some efforts in increasing the attractiveness for investors to invest into Polish shale gas by reducing bureaucratic hurdles and delaying the coming into force of the new tax law (Ecologic Institute & eclareon 2014, p. 12). This step increases the probability of a success of the decision in favor of shale gas exploitation.

As third relevant component for the analysis of maximal utility, explicit and implicit *costs* have to be looked at. Poland's engagement in fracking has not only been received positively, as there were protests in 2014 in the southeastern village of Żurawlów, were inhabitants protested against Chevron's shale drilling in their region and persistently blockaded the site (Neslen 2015, January 12th). The opposition of citizens can definitely be concluded as a cost of fracking for Poland as democratic country, even if their number is small and no nationwide organized anti-fracking movement has been launched.

International and national oil and gas companies influence the development of shale gas in Poland through their participation or absence but at the same time the government and its legislation is able to provide incentives for them to decide either opportunity. Resulting, the – now amended – Geological and Mining Law might have been an obstacle and therefore a cost for companies, as it required various bureaucratic steps to engage into exploration or drilling activities (see Chapter 4.2). For example, with the old regulations it could "take over a year for companies to obtain the permits to change their work programme" (The Economist 2013), which complicates the further planning and proceeding of activities. Bureaucracy is relevant for companies as it causes uncertainty and it is relevant for the government as it might "cost" the involvement of those companies.

With regard to its international responsibilities, Poland has to reduce its greenhouse gas emissions in context with the Kyoto Protocol. When the IEA last published a report on Poland in 2011, the country was beyond the targets of the Protocol (IEA 2011b, p. 12). This fact is mainly associated with Poland's high consumption of coal. To lag behind international targets could be seen as a cost of not developing the potential of shale gas, as the gas emissions of gas

[42] The consistency of the soil in Poland and the United States differs a lot, meaning that shale rocks carrying gas are located 1.5 times deeper in Poland than in the US, increasing drilling costs for 3 times, as technical equipment has to be suitable for higher requirements (Simon et al. 2013, p. 21, Albrycht et al. 2011, p. 66).

consumption would be significantly lower than those of coal, which would also favor "the objectives of European energy policy aimed at reducing green-house gases emissions (especially CO_2 emissions)" (Uliasz-Misiak et al. 2014, p. 75, see also European Commission 2010).

An important cost for Poland would be not to get involved into fracking, regarding the before mentioned promise of more autonomy through unconventional gas production, as the cost itself would be a persisting dependency on Russian imports (IEA 2011b, p. 10; Johnson, Boersma 2013, p. 397).

The weighing of all these aspects should in the end lead to a rational decision, assuming that Polish decision makers act rationally in the sense of choosing the alternative which brings most benefits and lowest costs for their country.

The general attitude towards fracking is positive[43], as high expectations were raised referring to an increase of welfare, lower gas prices for the population and economic growth, as it was mentioned by the former minister of economy, Piotr Woźniak (Ministry of the Environment 2012). These goals should be achieved "without damages of natural environment" (Ministry of the Environment 2012). Assumingly because of these expectations, the acceptance among a majority of the Polish society is high.

In the Energy Policy of Poland until 2030, clear priorities of Polish energy policies have been expressed, targeting "to enhance security of fuel and energy supplies; [...and] to develop competitive fuel and energy markets" (Ministry of Economy 2009, p. 4). Regarding the fourth sub questions of this work, to identify the rank of the environmental variable in the country's priorities, these targets are very unambiguous. Shale gas has been securitized in Poland (Johnson, Boersma 2013, p. 396), which makes energy security the highest priority in developing the unconventional gas exploration and exploitation.

While the amendment of the Mining Law aims at improving the transparency and accessibility for foreign investors, the new taxation system could be a constraint for the development of innovation and the proceeding of unconventional gas exploitation if fees exceed the economic profitability of the extraction (Uliasz-Misiak et al. 2014, p. 76; The Economist 2014). The comparability of the new Hydrocarbon Tax Law with the Norwegian version is seen as constraint for the industry as it might reduce eventual profits significantly (The Economist 2014).

When facing the number concessions already granted to international and national companies in the figure below, it becomes visible, that environmental concerns were not the determining factor for Poland in its decision making: while other European countries like France and Germany hesitated to implement the fracking technology, Poland allowed first exploration drillings

[43] According to a poll conducted by TNS Polska for the Ministry of Environment, which was not traceable in English, a majority of "72 percent of Poles living near shale gas exploration areas support the fuel's extraction" (HBW Resources 2013). Among all surveyed persons, 60% would agree to fracking activities in case it would be affecting their inmediate sourrounding and only 7% of all persons opposed fracking in general. (HBW Resources 2013)

in 2010 (The Economist 2013). Since then 70 exploration wells have been drilled, 16 of them in horizontal direction (PGI, NRI 2015).

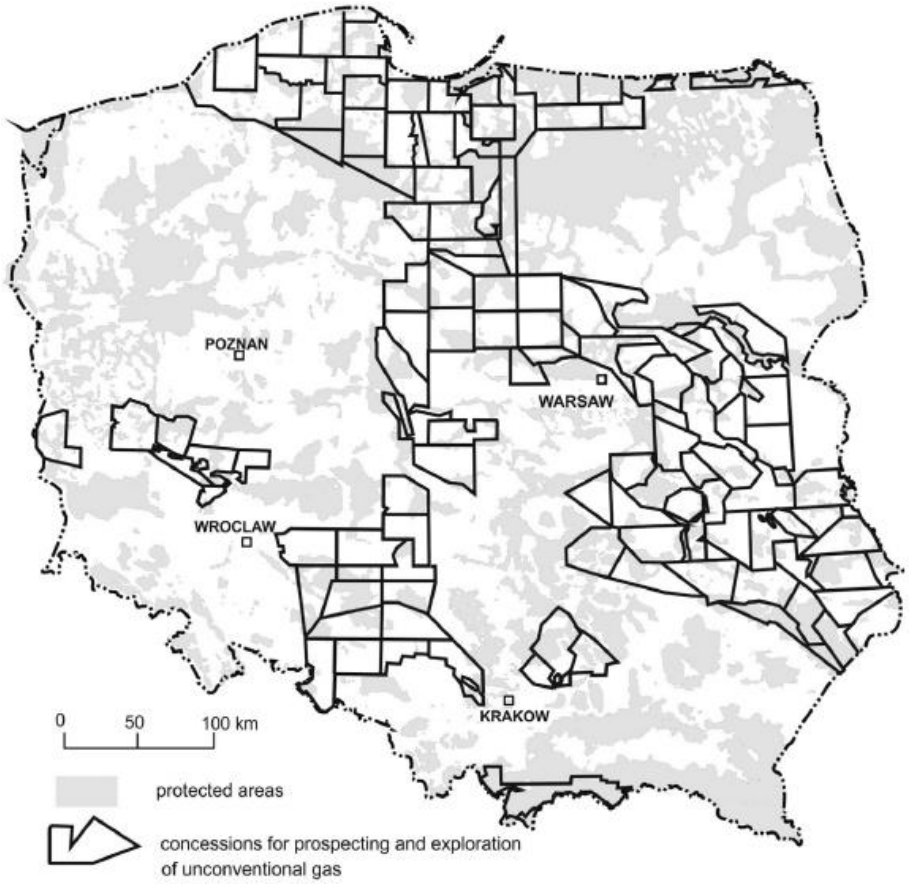

Figure 8 Concessions for exploration and prospecting of unconventional gas (based on Ministry of Environment 2012) against the background of protected areas in Poland (Uliasz-Misiak et al. 2014)

A diversification of energy sources belongs to the concept of Poland to gain more security of supply, but in contrast to e.g. Germany, where a phase-out from nuclear energy had been decided, Poland intends to establish more renewable energies but also nuclear energy and unconventional gas (KAS 2014, p. 42; Ministry of Economy 2009, p. 4). Accordingly, at the EU, Poland is interested in "pursuing a policy, at the legislative level and in the daily work of EU bodies, to develop its own raw materials base, especially of gas and oil from unconventional deposits" (Council of Ministers of the Republic of Poland 2012, p. 10).

Opposing to these efforts by the governing instances, constraints have occurred in the shape of unprofitability of Polish shale resources: as mentioned before, many involved oil and gas companies have abandoned Poland in the last years and "test wells have so far produced only 10% to 30% of the gas flow needed to be commercially sustainable" and at the same time "it costs as much as $25m to properly test a single well" (The Economist 2014), which is twice as much as in the United States. Furthermore, red tape has complicated and delayed exploration and drilling processes, which in the end were not very productive (Financial Times 2014). But, e.g. San Leon Energy is still working on its shale projects in Poland, acknowledging the improving support by the government (Financial Times 2014).

The report about the Łebień LE-2H exploratory well, published by the Polish Geological Institute, concluded that fracking "does not bear any long-standing influence on the environment, providing that it is appropriately performed, in accordance with the best professional knowledge and all the legal regulations" (Polish Geological Institute, National Research Institute 2011, pp. 59–62). Accordingly, the Prime Minister at that time, Donald Tusk, stated in 2011 that "well conducted exploration and production would not pose a danger to the environment" (Daly 2012, January 26th). The conclusion of environmental risks being not determining was also supported in a report released by The Kosciuszko Institute (2011, pp. 35–41).

In general, Poland itself does not have a strong environmental framework, but there are the binding "20-20-20" targets of the European Union that have to be fulfilled. Unconventional gas could be seen as a transition energy between the CO_2 emitting coal and the renewable energies, whose share of the energy mix has to be increased. The small interest of Poland in engaging into climate protection has been mentioned in a European Semester related report: "although 'Poland's Energy Policy up to 2030' lists climate-friendly goals for the energy sector […] there is little evidence of those goals being pursued" (Ecologic Institute & eclareon 2014, pp. 4–5).

Coming back again to the target triangle for energy policies, which are supposed to target (1) *security of supply*, (2) *profitability* and (3) *environmental compatibility*, the order of components reflects the prioritization of Polish interests. *Security of supply* is most likely to be endangered by human risks (Winzer 2012, p. 37), which equals with the intention of Poland to become independent from Russia. Further, *profitability* is pursued by the amendment of the Mining Law to make Poland easier to access for foreign investors. Environmental compatibility is targeted in a way, since natural gas causes less CO_2 emissions than the combustion of coal, which currently is the main energy carrier in Poland. *Environmental compatibility* is here seen as reducing the risk of another technology rather than excluding environmental risks of fracking as technique at hand. It can be summarized that hydraulic fracturing suits to Poland's energy policies and its national interest to pursue energy security and is not neglected by policy makers because of potential environmental risks.

4.4. Interim Conclusion of Country's Priorities

When analyzing the priorities determining Poland's attitude towards fracking activities, it becomes visible that other variables than the environmental variable, namely the security of energy supply, maintain the highest priority for the country. The government acts in favor of further testing and drilling of shale rocks to diversify their energy mix and to gain more independence from energy imports.

Furthermore, coal, which is Poland's main energy carrier, stands in conflict with the European "20-20-20" goals to reduce emissions by 20% until 2020. An increase of gas consumption would cause less emissions and could therefore be an accompaniment of renewable energy enhancement. Currently, the progress in shale gas exploitation is relatively slow due to eco-

nomic and geological obstacles that made companies abandon (testing) activities. As the Geological Mining Law has been reformed in order to make fracking more accessible to investors, the pursuit of energy security can be identified as higher priority for Poland than environmental protection, which has lost some relevance in the amendment of the law. The report about drilling in the Łebień well (2011) mostly refused environmental concerns, as well as a report published by The Kosciuszko Institute (2011).

Concluding, it can be stated that even if there are environmental concerns in studies and other countries, the Polish government still tries to develop shale gas as an opportunity for its energy security, its economy and a reduction of greenhouse gases caused by coal consumption, even if a success is not yet in sight.

5. Conclusion

Having analyzed the 'two similar cases' of Germany and Poland, a clear disparity in their evaluation and attitude towards fracking can be confirmed. As the countries are 'two similar cases' with regard to background conditions like being members of the European Union, which implies a) the obligation to ratify the second phase of the Kyoto Protocol[44], b) being obliged to fulfill the Europe 20-20-20 targets (European Commission 2010) plus the aims of the 2030 Framework for Climate & Energy[45] and c) being as well similar in terms of autonomy referring to the exploitation of national resources (European Commission 2014a, p. 1). Furthermore Germany and Poland are *net gas importers* with a large dependence on Russian gas, which amounts up to 80% of Polish imports and approximately 40% of German gas imports (BMWI 2015b; IEA 2011a, 2011b).

Although the cases are similar in the beginning, they differ on the independent variable (X) and the dependent variable (Y) (Seawright, Gerring 2008, p. 304). The dependent variable was the either *favoring* or *neglecting* attitude towards fracking in the countries and the independent variable consists of the countries' *national priorities*, which affect the outcome variable (Y).

Referring to the theoretical framework of this work, the analysis of the two countries has been conducted in the light of rational decisions made by the governments. For both, Germany and Poland, the evaluation of the possibility of shale gas production has led to the identification of individual preferences in terms of energy security and environmental protection, but also economic interests. As these preferences include both material and immaterial components, the costs and benefits that have been analyzed include therefore both economical and immaterial aspects, like the credibility of governments in the context of international protocols. Based on the assumption of utility maximization as guiding principle for the countries and their political priorities, the implementation of the fracking technology has been examined for its *utility*, the *probability of utility* and its *costs*. It is important to mention that priorities may vary, if costs and benefits change over time (Stocké 2002, p. 16). In the following, the main results of the analysis will be mentioned.

First of all there is the idea of an energy transition from fossil energies towards renewable ones. On the EU level there are the 20-20-20 targets which have been connected with the aims of the "Europe 2020 strategy for smart, sustainable and inclusive growth" (European Commission 2010), that demand changes of the energy mixes in the member states. Germany pursues

[44] The Council of the European Union adopted the a legislation to ratify the second phase of the Kyoto Protocol for 2013-2020, which will be ratified at the same time by the member states (European Commission 2015, July 14th)

[45] In October 2030, the European Council agreed on the 2030 Framework on Climate and Energy, extending the 20-20-20 targets from the Climate and Energy Package in 2009. The new targets include a reduction of greenhouse gases for 40% until 2030 (from 1990 levels), an increase of renewable energies in the total EU consumption up to 27% and as well an increase of energy efficiency (according to the old criteria) of 27% until 2030 (European Council 2014).

an additional own Energy Concept, having the aim of a "green economy" as key priority followed by a sustainable security of supply (BMWi, BMUB 2010). Poland, on the other hand, published an Energy Policy until 2030 which also contains the aim to reduce climate change related emissions but focuses on an enhanced security of energy supply and efficiency (Ministry of Economy 2009).

Until now, Germany performs well on its Energy Transition and lately renewable energies represented 25% of national energy production in 2014 (Leopoldina - The German National Academy of Sciences et al. 2015, p. 3). To meet its goal for 2020, the share of renewables on total energy consumption still has to increase to 18% from the 11.1% in 2014 (BMWI 2015a; European Parliament and the Council 2009, pp. Annex 1). Because of the decision for a nuclear phase-out and its low operating costs, coal-fired plants have been producing more energy in the last years, leading to a lightly increased CO_2 emission (Leopoldina - The German National Academy of Sciences et al. 2015, p. 3). In context with the avoidance of nuclear energy, the dependency on Russian gas imports is expected to augment distinctly until 2020 and Germany has to diversify its electricity production to assure the full capacity utilization of electricity grids which is currently granted through nuclear power plants (Jäger, Dylla 2008, p. 265). In contrast, Poland is working on the initiation of nuclear energy as a transition energy carrier from CO_2 emitting coal towards renewable energies. For the moment, Poland is performing well in achieving its target of a 15% share of renewables in total final energy consumption for 2020, as it amounted already 11.3% in 2013 (European Parliament and the Council 2009, pp. Annex 1; GUS 2014). In its own energy production, renewables only account for 4% (KAS 2014, p. 42).

The greatest difference between Germany and Poland can be found when it comes to terms of energy security. Poland strives to develop an approach to create independence from Russian gas imports while Germany pursues an approach of cooperative security[46], including relations with Russia (Jäger, Dylla 2008, pp. 262–263). One evidence for these diverging interests is the Nordstream pipeline, which caused a discord between Germany and Poland, as Germany favored the pipeline transporting Russian gas through Danish, Russian, Swedish, German and Finnish territories, while Poland decided not involve itself in this project due to its fear of even more energy dependency on Russian gas (Wojciechowski, Potyrala 2013, pp. 170,172). The economic interest of Germany to *improve* its security of supply through improved import channels is opposed by the Polish interest to *diversify* its import channels. In Poland, shale gas has therefore been securitized as it offers possibilities for a step towards more independency in terms of energy supply (Johnson, Boersma 2013, p. 396). On the contrary, fracking in Germany has mainly been analyzed for its potential contribution to economic profits and as additional source for the purpose of diversification.

[46] Cooperative security, as defined by the NATO is a concept, which originally includes "strengthening partnerships, contributing to arms control, non-proliferation and disarmament, and assisting potential new countries to prepare for NATO membership". In this context, it can also be understood as a more political intention of an "engagement which provides increased collaboration between different actors resulting in information sharing and the harmonization of resources and capabilities". (NATO 2011, September 7th)

In Germany a decrease of diversity in energy sources can be observed by excluding fossil resources and nuclear energy while broadening the variety of renewable energy carriers. At the same time but on opposite terms, Poland tries to invest in diversification of energy supply with employing fracking for further gas exploitation and establishing nuclear energy production.

While in Germany the environmental concerns about fracking have been acknowledged and hesitation was visible in distributing exploration licenses, in Poland the aspect of possible energy security has influenced the decision making process in favor of an establishment of the technique.

All these aspects contribute to answering the initially formulated research question. The environmental costs of hydraulic fracturing and its significance for energy security have been outlined in Chapter 2 in order to answer the first and second sub questions, and in the analyzing Chapters 3 and 4, the individual priorities of Germany and Poland have been examined.

As a conclusion, it can now be stated that the evaluation of a potential shale gas exploitation has been assessed differently due to a distinct evaluation of national priorities. Although the element of energy security has a high priority for both countries, environmental compatibility obeys to different priorities. The outcome of the evaluation of a potential shale gas exploitation does therefore vary between Germany and Poland.

In Germany, environmental protection obeys to a high rank of priority, making the implementation of fracking an incalculable risk, as German authorities and institutions cannot foresee the consequences of the technique yet. This result answers the forth sub question regarding to the prioritization of the environmental variable in the countries. The variable of energy security is addressed by diversifying energy sources through developing renewable sources further and broadening their variety. For a security of supply in electricity, Germany engages in an “enhanced energy efficiency, the expansion of grids and the construction of new storage facilities” (BMWi, BMUB 2010, p. 4). Concerns are connected with the adequate provision of new energy carriers and not with potential political insecurity intervening on imports.

Summarizing, this means that the environmental variable is of higher priority in Germany than the variable of energy security. Like this, the Renewable Energies Act represents the aim to enhance renewable energies and to protect fossil resources, which include also shale gas, in order to achieve energy security (BMWI 2015c). The support of the Energy Transition by the German Society still remains high (Leopoldina - The German National Academy of Sciences et al. 2015). Economic profits have not resulted as incentive for Germany to establish shale gas as energy carrier. The third sub question can be responded as Germany’s energy and environmental policies are not congruent with the development of shale gas as an additional energy source. In a rational analysis of costs and benefits for the country, shale gas is not a highly prioritized possibility for Germany as it is visible in former hesitation and its focus on the development of renewable energies.

In Poland, energy security obeys to the highest rank of priority in the matter of fracking. Like this, the Polish government has granted licenses in an early stage and tries to provide incentives for investors through jurisdictional adjustments. A commercial production of shale gas is supposed to contribute to Poland's economic performance and state revenue. The ambition to gain more independence and financial profit, prevails over the concerns of environmental hazards through fracking. International agreements on environmental protection and climate change are pursued by the intention to reduce coal as main greenhouse gas emitter and to substitute it by either more natural (shale) gas or nuclear energy (Ministry of Economy 2009, pp. 4–5). Concluding with regard to the forth sub question, the environmental variable results to have a lower priority than energy security and economic profits.

In conclusion, the main reason why shale gas would not be exploited in Poland would be the inaccessibility or the costly extraction of reserves which have already made companies abandon the country. Concluding and giving a response to the third sub question, it can be underlined that for Poland – in contrast to Germany – the exploitation of shale gas is a relevant possibility to pursue its other political targets, as the benefits of shale gas prevail over the costs of not establishing its production.

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Figures

Figure 1 Fracking: Typical Horizontal Drilling (Argonne National Library 2013, p. 2)..... 12
Figure 2 Price of Natural Gas (NG: 1) from 2010 to 2015 http://www.bloomberg.com/quote/NG1:COM..... 16
Figure 3 Global Natural Gas Prices (Mearns 2013) 17
Figure 4 Supply situation for non-renewable energy resources at the end of 2012 (BGR 2013, p.35)..... 19
Figure 5 Target Triangle for Energy Politics (own diagram, cf. Mükusch 2011)..... 24
Figure 6 Areas in Germany were fracking could be profitable: Grey stands for areas where shale gas can be expected from a geological perspective, green marks granted exploration licenses (FAZ 2015, April 4th)..... 26
Figure 7 Target Triangle for Energy Politics (own diagram, cf. Mükusch 2011)..... 33
Figure 8 Concessions for exploration and prospecting of unconventional gas (based on Ministry of Environment 2012) against the background of protected areas in Poland (Uliasz-Misiak et al. 2014) 37

Tables

Table 1 Components of TPES in Germany in 2011 and 2014 (own table; IEA 2013, BMWi 2015a) 22
Table 2 Components of TPES in Poland in 2011 and 2014 (own table; IEA 2011b, GUS 2014) 31

Abbreviations

acatech	German National Academy of Science and Engineering
API	American Petroleum Institute
BDI	The Voice of German Industry (Bundesverband der Deutschen Industrie e.V.)
BGR	Federal Institute for Geosciences and Natural Resources
BMUB	German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BMWI	Bundesministerium für Wirschaft und Energie
BUND	German Federation for Environment and Nature Conservation (Bund für Umwelt und Naturschutz Deutschland)
EPA	United States Environmental Protection Agency
EU	European Union
FAZ	Frankfurter Allgemeine Zeitung
Fracking	Hydraulic Fracturing
GHG	Greenhouse Gas
IEA	International Energy Agency
KAS	Konrad Adenauer Foundation
MKULNV	Ministry for Climate Protection, Environment, Agriculture, Conservation and Consumer Protection of the State North Rhine Westphalia
Mtoe	Million Tonnes of Oil Equivalent
PGI, NRI	Polish Geological Institute; National Research Institute
PGNiG SA	Polish Oil and Gas Company
TPES	Total Primary Energy Supply
U.S. Energy Information Administration	EIA
UBA	German Federal Environmental Agency (Umweltbundesamt)

Annex

a. FAZ (2015, April 1st)

Frankfurter Allgemeine
Wirtschaft
Mittwoch, 22. Juli 2015

Umstrittene Fördertechnologie

Abgeordnete stellen sich gegen Fracking-Gesetzentwurf

Kommt Fracking oder doch nicht? So ganz ist das auch nach dem Gesetzesentwurf nicht klar, der das Kabinett am Mittwoch passierte. Mehr als 100 Bundestagsabgeordnete sind unzufrieden.

01.04.2015

© AFP

Umweltaktivisten demonstrieren vor dem Kanzleramt in Berlin

Nach langer Debatte soll das umstrittene Gas-Fracking in Deutschland unter strengen Auflagen nur zu Probezwecken erlaubt, eine spätere großflächige Förderung aber nicht ausgeschlossen werden. Das Kabinett beschloss am Mittwoch in Berlin einen Gesetzentwurf des Bundesumwelt- und Bundeswirtschaftsministeriums. Die von Bundesumweltministerin Barbara Hendricks und Wirtschaftsminister Sigmar Gabriel (beide SPD) erarbeiteten Gesetzesänderungen sollen den Einsatz der Technologie in Deutschland grundsätzlich regeln.

Der Einsatz von Fracking in unkonventionellen Lagerstätten in Schieferschichten sowie Kohleflözen oberhalb von 3000 Metern zu wirtschaftlichen Zwecken soll grundsätzlich verboten werden. Auch in sensiblen Regionen wie Wasserschutzgebieten soll es kein Fracking geben. Allerdings sollen wissenschaftliche Probebohrungen mit nachweisbar für das Trinkwasser ungefährlichen Frackingflüssigkeiten möglich bleiben - ebenso wie anschließende Ausnahmen für kommerzielle Abbauvorhaben. Dies stößt bei Fracking-Gegnern auf Kritik. Die Regierung will zudem die Durchsetzung von Schadenersatzansprüchen bei Schäden erleichtern, die durch Fracking entstanden sind - wie zum Beispiel Risse in Hauswänden. Dazu wird die Beweislast, dass ein sogenannter Bergschaden nicht durch ein Fracking-Vorhaben verursacht wurde, künftig grundsätzlich dem Unternehmer auferlegt.

Bisher gar keine Regelung

Bisher gibt es keine gesetzliche Regelung. Ein erster Anlauf war 2013 gescheitert, weil Vorschläge der damaligen Bundesregierung aus Sicht einiger Unions-Abgeordneter keinen ausreichenden Wasserschutz boten. Auch jetzt drohen mehrere Dutzend Abgeordnete der Unions-Fraktion mit einer Ablehnung im Bundestag. „In dieser Form ist der Gesetzentwurf für zahlreiche Kolleginnen und Kollegen nicht zustimmungsfähig", sagte der CDU-Abgeordnete Andreas Mattfeld der Deutschen Presse-Agentur. Notwendig sei eine Verschärfung. Die Gruppe der Fracking-Kritiker umfasse bereits über 100 Unions-Abgeordnete, betonte Mattfeld.

„Wir können uns nicht vorstellen, dass flächendeckend in Deutschland Erprobungsmaßnahmen stattfinden. Wir halten eine Quantifizierung für sinnvoll, orientiert an geologischen Gegebenheiten." Es wäre klug gewesen, Änderungen etwa zum Umgang mit Lagerstättenwasser vor der Kabinettsbefassung einzuarbeiten. Aber scheinbar gehe es zum Beispiel Ministerin Hendricks „ein Stück weit vielleicht auch um Eitelkeiten", sagte Mattfeld. In der SPD wiederum gibt es starken Widerstand gegen eine geplante Kommission, die nach einer erfolgreichen Erprobungsmaßnahme in dem betreffenden Gebiet dann grünes Licht für kommerzielle Projekte geben kann. „Ich will, dass der Bundestag das Heft des Handelns in der Hand hat und darüber entscheidet", sagte der SPD-Politiker Frank Schwabe. Die Kommission sei ein Zugeständnis an die Gasunternehmen.

Bei der Fracking-Methode wird unter hohem Druck ein Gemisch aus Wasser, Sand und Chemikalien in den Boden gepresst, um undurchlässige Gesteinsschichten aufzuspalten und das darin enthaltene Erdgas oder -öl zu fördern. Fracking kommt bei konventionellen wie unkonventionellen Lagerstätten zur Anwendung. Das konventionelle Fracking wird hierzulande schon seit den 60er Jahren angewendet und soll weiter erlaubt bleiben. Allerdings sollen die Regelungen verschärft werden.

b. The Economist (2013)

Shale gas in Poland

Mad and messy regulation

Jul 10th 2013, 17:00 by A.E. | WARSAW

POLISH dreams that shale gas would transform the country into a second Norway have been tempered in recent months. The geology is more difficult than anticipated and proposed regulation has been repeatedly delayed. After great initial enthusiasm companies such as ExxonMobil, Talisman and Marathon Oil threw in the towel and quit the country.

In a recent report investors complained that the legislation currently being drawn up ignores many of their demands. The Polish Exploration and Production Industry Organisation (OPPPW), the industry's main lobby group, is concerned the government will get "excessive controls and rights" in shale gas exploration. They say the ministry of environment handed out five-year exploration licences to companies and they can be extended only once, for two years. (The first ones will expire in 2013-2014.) Since shale gas fields take longer to develop than conventional fields, says the OPWW, they will have insufficient time to make discoveries before the deadline, at which point they either have to apply for a production licence or hand it back to the ministry.The lobby also criticises the proposed laws for imposing disproportionate penalties on them if they fall behind in their work schedules due to circumstances beyond their control.

The Polish government used to be gung-ho on shale gas. Unlike many of their contemporaries in western Europe, Poland's politicians brushed aside environmental concerns, impressed by estimates that the country was sitting on the largest shale gas reserves on the continent. Extracting oil and gas from shale offered solutions to two particularly thorny problems, namely how to reduce the country's dependence on costly Russian gas imports and cut greenhouse gas emissions from its heavily-polluting coal-fired power plants.

The former Soviet-bloc country inherited gas infrastructure built to transmit gas in one direction only, from the east. Since 1989 Polish politicians have been trying, spectacularly unsuccessfully until recently, to diversify the country's energy supplies. As a result they have been forced to accept gas import prices higher than those paid by their richer western neighbours.

Burning gas emits fewer CO_2 emissions than coal or oil but Poland sits on the largest coal reserves in the European Union and it has built more than two decades of economic growth on coal-fuelled power. Currently Poland produces more than 90% of its electricity in coal or lignite-fired power plants. In recent years Warsaw has found itself alone in resisting demands from Brussels to adopt more stringent emissions targets. Commercial shale-gas production would allow Poland to shut down older polluting coal plants and replace them with gas-fired plants, thereby reducing the country's emissions.

So it's easy to see why, in April 2010, before a single exploration well had been drilled, the Polish foreign minister, Radoslaw Sikorski, said shale gas offered Poland the chance to replicate Norway's success. By then, both foreign and Polish oil and gas companies had rushed to grab exploration acreage, attracted by a combination of gas prices four to five times higher than in America, fields close to the market and a government that was actively promoting the industry.

The first exploration well was drilled in June 2010. To date around 40 wells have been drilled, more than anywhere else in Europe. Not one has flowed gas at a commercial rate.

ExxonMobil quit Poland in June last year after drilling just two wells. In May of this year Canada's Talisman and Marathon Oil, an American firm, also withdrew from Polish exploration citing unsatisfactory results. Operators admit the technology of extracting gas from Polish shale has proved harder to crack than they anticipated.

Even so, Pawel Poprawa, a geologist from the Energy Studies Institute, who authored the Polish Geological Institute's estimate of the country's shale gas reserves, says far too few wells have been drilled to draw conclusions about the rocks. Only four horizontal wells have undergone multi-stage hydraulic fracturing, the best indicator of a field's reserves. The government's proposed fiscal and regulatory framework is the main reason why companies slowed the pace of their exploration in recent months, says Mr Poprawa says. It was variously described to our correspondent as "mad" and "a mess" by industry executives.

The current regulations are inadequate. It can take over a year for companies to obtain the permits to change their work programme and drill a well deeper for example. The government wants to increase its take from a commercial shale gas industry. It has proposed new taxation capping the government take at 40% of an operator's profits. Companies acknowledge new taxes will be introduced but argue that talk of figures is premature given no one knows yet if shale gas will prove to be commercially viable in Poland. The ministry of finance has eased matters by saying it will postpone the collection of any new taxes from 2015 to 2020.

More controversial are the draft regulations proposed by the environment ministry that will create the state-owned company, NOKE, to take stakes in all future production concessions as a way of guaranteeing the state's interest in future production. Operators are concerned they are being forced to take on a partner in NOKE that, unlike the Norwegian state company it is based on, will be staffed by public administrators with no experience of unconventional hydrocarbons.

Companies that have already invested millions of dollars drilling wells are also worried the proposals do not give them a legal guarantee to transfer their existing exploration licenses into production licenses without taking part in a competitive tender. "If there is a change in the government's approach then it is not too late for this industry to patiently work its way through the problems with some realistic prospect of success. If we continue on the road we're on at the moment, this industry will be very modest and will not fulfil its potential," said Tomasz Maj, until recently Talisman's Poland manager.

c. Navarro (2012), In: The New York Times

Wastewater Becomes Issue in Debate on Gas Drilling

Vexed by declining revenue, officials of the Niagara Falls water utility seized on a new moneymaking idea last year: treat toxic waste from natural-gas drilling at its sewage-treatment plant once hydrofracking gets under way in New York State.

Accepting the waste would both offset the drop in revenue and help keep water rates down for customers in the economically strapped region, they reasoned.

But the thought of having fracking fluids trucked into the city, treated and discharged into the Niagara River frightened local residents, many of whom still recall the Love Canal environmental crisis of the 1970s. In a unanimous vote, the Niagara Falls City Council blocked the plan this spring by banning the treatment, transport, storage and disposal of drilling fluids within city limits.

"We're not going to deal with this again — a chemical disaster," said the council chairman, Samuel Fruscione.

As New York State environmental regulators fine-tune proposed rules governing horizontal hydraulic fracturing, or fracking, a controversial natural-gas extraction process, wastewater has emerged as a challenging issue for the industry and regulators.

The drilling involves injecting vast amounts of water and chemicals into underground shale to release the gas. Should it begin in New York, the gas wells could generate hundreds of millions of gallons of toxic wastewater annually, and it is not clear where it could go.

Federal officials have warned that New York should not count on the disposal options that it now uses for salty wastewater from conventional gas wells, which produce far less waste than fracking. Most of the state's conventional drilling waste stays in New York and is sent to sewage-treatment plants like one in Auburn, N.Y., near Syracuse or is used to de-ice roads or tamp down dust on them, state regulators said. The state also sends waste to privately owned treatment plants in Pennsylvania and Ohio. In written comments on New York's proposed fracking rules, the federal Environmental Protection Agency has said that the state should ban the use of fracking brine on roads because pollutants could make their way into aquifers and waterways through infiltration and storm runoff.

The agency also warned that there was probably not enough capacity at out-of-state treatment plants to handle polluted water from New York.

The E.P.A. is currently working on national pretreatment standards for waste headed for municipal sewage-treatment plants or private treatment plants, after finding that many of them are not properly equipped to treat this type of wastewater and may be discharging pollutants to rivers and other streams.

Building new treatment plants for the fracking industry is another option, but industry representatives say that doing so would depend on whether the investment makes economic sense. Complicating matters, antifracking sentiment has already led to dozens of bans or limits on fracking-related operations, like the measure in Niagara Falls.

"Wastewater management represents a challenge to the industry," said John Conrad, a co-owner of P. V. E. Sheffler, an engineering and environmental consultant to energy companies that are already drilling in Pennsylvania and other states. "A lot of treatment capacity still remains to be built."

Environmental groups, arguing that the state is already lax in policing wastewater disposal, say that the State Environmental Conservation Department, which would issue drilling permits, must come up with an exhaustive plan to make sure that it is handled safely.

"For the D.E.C. to sidestep this issue would be an abdication of its responsibility," said Eric A. Goldstein, a senior lawyer with the Natural Resources Defense Council and a member of a panel advising Joe Martens, the commissioner of the Environmental Conservation Department, on the fracking proposal. "The industry's environmental track record in other states does not inspire confidence."

The state environmental agency has already made clear that specific disposal plans must be in place before any drilling permits will be issued — and that finding sites will be up to the gas industry.

"This is the industry's problem," Mr. Martens said in an interview. "It's not the state's responsibility to identify disposal sites."

Some industry officials played down the challenges, saying that technological advances are allowing them to recycle most of the waste. Along with more traditional methods like injection wells, which involve pumping waste into underground rock formations, new treatment plants are already coming online in Pennsylvania.

"As the development moves to New York, the infrastructure will be developed here," said John Holko, president of Lanape Resources, a company with interests in 500 conventional gas wells in New York, who is a spokesman for the Independent Oil and Gas Association of New York.

Casella Waste Systems, a landfill operator that is building a recycling and disposal plant for fracking waste in McKean County, in Pennsylvania, said it could easily build similar plants at two of its landfills in New York if there is sufficient demand for treatment.

Some environmental groups argue that, based on how New York now handles waste from conventional drilling, the state would be ill-prepared to deal with the enormous amount of wastewater produced by thousands of fracked wells.

Environmental Advocates of New York, a group based in Albany, plans to release a report on Friday asserting that the state does not adequately track where the waste from more than 6,800 conventional wells now operating goes. In a review of nearly 100 drilling permits, the group found that New York requests minimal information on waste disposal.

Asked about disposal plans, companies in many cases replied in vague terms, like "hauled to an approved disposal facility," Environmental Advocates said.

"Following the waste stream from a well to ultimate disposal is nearly impossible," the group said.

State officials counter that their proposed drilling rules will impose a stringent waste tracking system.

Stuart Gruskin, a former deputy commissioner of the Environmental Conservation Department, who worked on the first draft of the rules and now does consulting work, said he had no doubt that fracking waste could in principle be disposed of safely. But finding adequate treatment capacity will be a challenge, he said.

"This is going to be a limiting factor in New York," he said.

d. BUND (2015, April 1st)

***BUND* Bund für Umwelt und Naturschutz Deutschland**

1. April 2015

BUND kritisiert "Fracking-Ermöglichungsgesetz"

Jetzt sind NRW-Abgeordnete und die Landesregierung gefordert

Anlässlich der heute vom Bundeskabinett gebilligten Kabinettsbeschlüsse zur Fracking-Technologie fordert der nordrhein-westfälische Landesverband des Bund für Umwelt und Naturschutz Deutschland (BUND) die NRW-Bundestagsabgeordneten zum Widerstand gegen das „Fracking-Ermöglichungsgesetz" auf. Der von der Bundesregierung geplante Rechtsrahmen würde Tür und Tor zum Einsatz der Risiko-Technologie auch in Nordrhein-Westfalen öffnen. Aber auch die Landesregierung sei gefordert.

„Es ist schon erstaunlich, dass die vom Niederrhein stammende Bundesumweltministerin Hendricks die von der NRW-Landesregierung und dem NRW-Landtag getroffenen Beschlüsse gegen Fracking ignoriert und die Interessen der Energiekonzerne offenbar höher gewichtet als den Schutz von Mensch und Umwelt", sagte BUND-Geschäftsleiter Dirk Jansen. Würde der rechtliche Rahmen mit der umstrittenen 3.000 m-Regelung vom Bundestag verabschiedet, sei damit unmittelbar der Weg frei für Fracking-Bohrungen am südlichen Niederrhein und im zentralen Münsterland. Die vorgesehene Möglichkeit von Probe-Bohrungen sei zudem eine Hintertür zur landesweiten Etablierung der riskanten Fördertechnik.

„Jetzt sind die NRW-Bundestagsabgeordneten gefordert, ihren Worten auch Taten folgen zu lassen", sagte Jansen. „Das Gesetzespaket muss im Parlament abgelehnt werden. Wir brauchen stattdessen ein generelles Fracking-Verbots-Gesetz." Aber auch die NRW-Landesregierung sei in der Pflicht. Jetzt müsse Ministerpräsidentin Kraft ihre Ankündigung wahrmachen, dass es hierzulande kein Fracking geben werde, solange sie im Amt ist. Das Mindeste sei, sich für eine uneingeschränkte Länderöffnungsklausel einzusetzen. Daneben müsse das Land aber auch die eigenen Möglichkeiten nutzen und zum Beispiel im Zuge der Aufstellung des Landesentwicklungsplanes ein Ausschluss der Fracking-Technologie verankern.

...mehr Fracking-Infos

zurück zu: Pressemitteilungen

Quelle: http://www.bund-nrw.de/nc/presse/pressemitteilungen/detail/artikel/bund-kritisiert-fracking-ermoeglichungsgesetz/

e. Marshall (2011), In: New Scientist

DAILY NEWS 2 November 2011

How fracking caused earthquakes in the UK

In April and May this year, two small earthquakes struck the UK near the town of Blackpool. Suspicion immediately fell on hydraulic fracturing, known as fracking – a controversial process to extract natural gas by fracturing the surrounding rock. A report has now confirmed that fracking caused the earthquakes.

New Scientist looks at what happened, and whether fracking is likely to cause more earthquakes.

When and where did the earthquakes happen?
A magnitude-2.3 earthquake occurred on 1 April, followed by a magnitude-1.5 quake on 27 May. Both occurred close to the Preese Hall drilling site, where Cuadrilla Resources was using fracking to extract gas from a shale bed.

Initial studies by the British Geological Survey (BGS) suggested that the quakes were linked to Cuadrilla's fracking activities. The epicentre of the second quake was within 500 metres of the drilling site, at a depth of 2 kilometres. Less information was available on the first quake, but it seems to have been similar.

The link with fracking has now been confirmed by an independent report commissioned by Cuadrilla, *Geomechanical Study of Bowland Shale Seismicity*, which states: "Most likely, the repeated seismicity was induced by direct injection of fluid into the fault zone."

The two geologists who wrote the report ran detailed models to show that the fracking could – and most likely did – provoke the quakes.

How did the fracking cause the earthquakes?
Fracking works by injecting huge volumes of water into the rocks surrounding a natural gas deposit. The water fractures the rocks, creating dozens of cracks through which the gas can escape to the surface.

The UK quakes were not caused by the violent rupturing of the rocks, as you might expect, but by the presence of water. This lubricates the rocks and pushes them apart, allowing them to slip past each other. "It's a bit like oiling the fault," says Brian Baptie of the BGS.

Seismologists have not been able to find the fault that moved, probably because it is tiny. Baptie says the surface area of the fault is likely to be just 100 metres by 100 metres, and that the rocks moved by about 1 centimetre – the seismological equivalent of a needle in a haystack.

So should we expect lots more earthquakes from fracking?
It's difficult to say. Fracking has been going on in the US for decades, and has become much more common in recent years, yet evidence that it causes earthquakes has so far been elusive. "This is one of the first times felt earthquakes have been associated with fracking," Baptie says.

The Cuadrilla report says the earthquakes occurred because of a rare combination of circumstances: the fault was already under stress, was brittle enough to fracture and had space for large amounts of water that could lubricate it. The report says this is unlikely to happen again at the Preese Hall site.

Baptie is not so sure. He says small faults are probably common in deep rocks, but go undetected because of their size. "It seems quite possible, given the same injection scheme in the same well, that there could be further earthquakes," he says.

Cuadrilla is proposing to monitor seismic activity around its fracking site. If earthquakes begin to occur, it could reduce the flow of water into the well, or even pump it back out, preventing the bigger quakes. Baptie says such monitoring is now necessary to avoid further quakes at fracking sites.

Are these earthquakes dangerous?
Not particularly. Magnitude-2.3 earthquakes can shake the ground enough for people to notice, especially if they occur close to the surface, but damage is normally limited to objects falling off shelves.

According to Baptie, the UK gets an average of 15 magnitude-2.3 earthquakes every year, so the quakes produced by the fracking are not out of the ordinary.

By **Michael Marshall**